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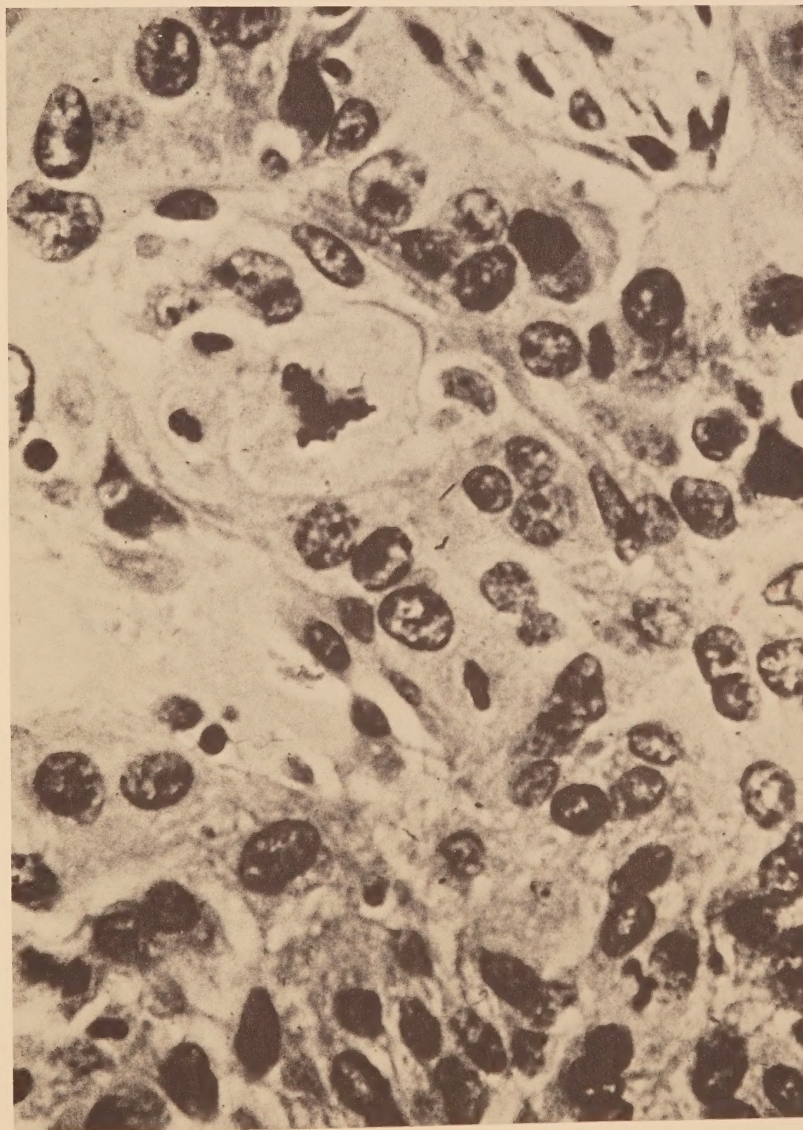
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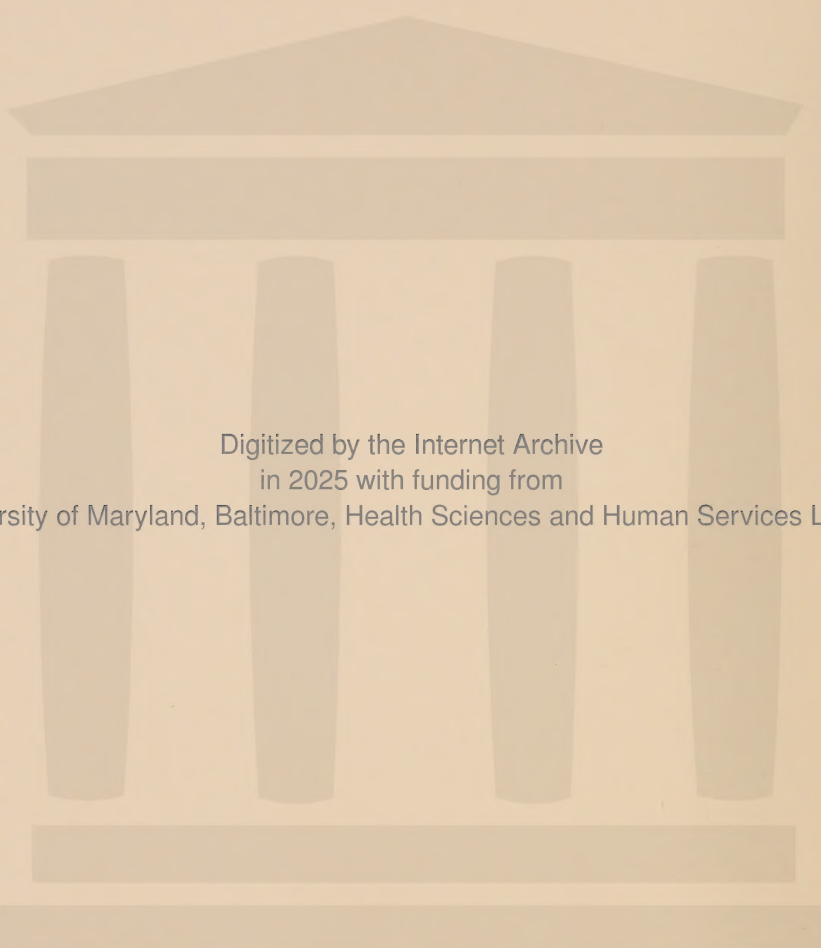
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Grade III Epidermoid Carcinoma of the Tongue 475X. Compliments, Department of Oral Pathology, University of Maryland, Dental School.

The Role of Chemotherapy in the Management of Cancer of the Head and Neck

Stewart A. Bergman, D.D.S.

ABSTRACT

Survival statistics of patients with advanced or recurrent squamous cell carcinoma of the head and neck are very poor. Chemotherapy has been used in an attempt to improve survival. Several drugs have been shown to produce convincing and reproducible tumor regression. However, tumor recurrence or tumor progression was noted in almost all cases, regardless whether single or multiple drugs were used. Adjuvant chemotherapy along with the local treatments of surgery and radiotherapy appear to have significantly increased the tumor free interval. However, it is too early to determine whether such combination therapy will improve survival.

The objective of cancer therapy is to destroy, remove, or neutralize all malignant cells.¹ It is unknown if successful treatment requires that all neoplastic cells be irradiated or merely reduced to a small number easily destroyed or controlled by host immunological defenses.

Cancers in general can be divided into two major types; solid and hematologic malignancies. Solid tumors are, in their early stages, confined to a specific site. However, with increasing size, some malignant cells break off from the original tumor mass, enter the lymph or blood drainage systems, and seed distant sites. In some cancers, e.g. malignant melanoma, the tumor need not achieve a large size before metastases occur,² whereas, in epidermoid carcinoma of the lip metastases do not frequently occur until the tumor has achieved a considerable size, 2 cms. or greater.² When metastases are present the disease is said to be in the disseminated stage. On the other hand, hematologic malignancies involve the blood and lymph systems at onset and for this reason are frequently disseminated diseases from the beginning.

Five therapeutic modalities are available to the oncologist: surgery, radiotherapy, chemotherapy, immunotherapy, and endocrine therapy. In solid tumors, surgery and/or radiotherapy are the traditional primary treatment modalities. However, once the tumor has metastasized beyond the first order regional lymph nodes neither modality can be considered curative. It is for disseminated disease that the other modalities of treatment are used. Endocrine therapy has no role in the treatment of epidermoid carcinomas.

The American Cancer Society reports that in the United States there are approximately 24,000 new cases of oral and oropharyngeal carcinoma reported annually; oral cancer accounts for one of every forty (40) deaths from cancer of all causes.³ In the early stages of these diseases Stage I and II (see Table 1) surgery and/or radiotherapy alone or in combination, have been able to achieve relatively good five year survival rates ranging from 60-90% depending on site of the tumor.⁴ However, in more advanced disease stage III and IV, these two treatment modalities have achieved relatively poor five year survival rates varying from 10-49% depending on the primary site.^{4,5,6} In general, the farther back in the oral cavity (lip to pharynx) the site of the primary tumor is and the more poorly differentiated the tumor, the poorer the prognosis. Oral carcinoma, as in the case of many cancers, are usually not detected until the disease is well advanced. Many of the victims of the disease are alcohol abusers. These people generally have poor images of themselves and tend to be neglectful. They do not present for regular medical or dental care. Oral carcinoma is a silent disease and does not produce symptoms until the disease is well advanced. It has been shown that the larger the primary tumor, the more likely distant metastases will occur.

TABLE I

| | | | | | |
|-----------------------------------|---|----------------|----------------|----|----------------------------------|
| Stage I | - | T ₁ | No | Mo | |
| Stage II | - | T ₂ | No | Mo | |
| Stage III | - | T ₃ | No | Mo | |
| | | T ₁ | N ₁ | Mo | |
| | | T ₂ | N ₁ | Mo | |
| | | T ₃ | N ₁ | Mo | |
| Stage IV | - | T ₁ | N ₂ | Mo | T ₁ N ₃ Mo |
| | | T ₂ | N ₂ | Mo | T ₂ N ₃ Mo |
| | | T ₃ | N ₂ | Mo | T ₃ N ₃ Mo |
| or any T or N with M ₁ | | | | | |

**Staging of Squamous Cell Carcinoma of Oral Cavity
and Oropharynx Based on TNM System
American Joint Committee for Cancer Staging**

| | | |
|----------------|---|--|
| T | - | Primary Tumor |
| Tis | - | Carcinoma in Situ |
| T ₁ | - | Tumor ≤ 2 cm. in greatest diameter |
| T ₂ | - | Tumor > 2 cm. but ≤ 4 cm. in greatest diameter |
| T ₃ | - | Tumor > 4 cm. in greatest diameter |
| N | - | Regional lymph nodes |
| N | - | Regional lymph nodes |
| No | - | No clinically palpable cervical lymph node(s) |
| N ₁ | - | Clinically palpable homolateral cervical lymph node(s) that are not fixed |
| N ₂ | - | Clinically palpable contralateral or bilateral cervical lymph node(s) that are not fixed |
| N ₃ | - | Clinically palpable lymph node(s) that are fixed |
| M | - | Distant metastases |
| Mo | - | No distant metastases |
| M ₁ | - | Clinical and/or radiographic evidence of metastases other than cervical lymph nodes |

In the case of carcinoma of the tongue, the second most common oral carcinoma (lip being 1st) 40% of the patients will seek treatment with distant or regional lymph node metastases already present, and 40% of the remainder will develop metastases even with successful irradiation of the primary tumor.⁷ This suggests that metastatic disease was present in approximately 70% of these patients prior to, or at the time of, the first treatment. The statistics for carcinomas at other sites in the oral cavity are somewhat better but are still devastating. This is reflected in an overall five year survival of 20-40% in all sites for stage III and IV diseases.^{2,7} Clearly what is needed is a modality or modalities of treatment which can effectively irradiate these microscopic metastases. Chemotherapy is such a modality of treatment.

Chemotherapeutic agents are aimed at achieving selective kill of malignant cells. There is no unique or specific difference between cancer cells

and normal cells. Consequently, there is no chemotherapeutic agent with specific action on cancer cells. Host toxicity, therefore, always occurs. The beneficial effects of chemotherapy are due to quantitative, not qualitative differences between malignant and normal cells.

Several drugs have been shown to be effective in treatment of head and neck squamous cell carcinomas. These include methotrexate (MTX),^{8,9} hydroxyurea,^{9,10} adriamycin,¹¹ bleomycin,¹² and cis-platinum.^{13,14} Regardless of which drug was used in the treatment of head and neck carcinoma, tumor recurrence and/or tumor progression was noted 8-12 weeks after completion of the therapeutic course. This is the case whether the drug is given systemically or intra-arterially. In attempting to overcome this dismal result, chemotherapists have turned to combination chemotherapy. It was hypothesized that using several drugs, each presumably acting by different mechanisms, would increase the tumorcidal effect by acting synergistically, without increasing the toxic effects to the host. However, several studies^{9,15,16} using multiple drug regimens have not significantly improved cure rates. One study¹⁷ recently completed made use of a three drug regimen MTX, cis-platinum, and bleomycin. These drugs were used in the maximum doses tolerated by the patient. Despite the fact that a 78% response rate was obtained, local recurrence and/or progression of tumor was detected 8-12 weeks post therapy. This leads to the conclusion that chemotherapy alone is incapable of destroying all malignant cells. Chemotherapy, therefore, should only be used as an adjuvant to surgery and/or radiotherapy in the management of local and regionally advanced cases.

One approach has been the use of chemotherapy followed by irradiation^{18,19,20} or concomitant chemotherapy and radiation therapy.^{21,22} Most of these studies show no significant difference in terms of curability between radiotherapy alone or chemotherapy and radiotherapy combined. However, excellent tumor regression was obtained. Several of these patients were found to have persistent tumor in bone. This suggests that surgery is necessary in addition to chemotherapy and radiation therapy to irradiate the tumor completely. Similar conclusions have been reached in other studies.^{23,24}

In contrast to the relatively large number of published studies on chemotherapy plus radiotherapy in oral epidermoid carcinoma, there is very little data for surgery plus chemotherapy. Golomb and Wright²⁵ reported a series of ten cases of

squamous cell head and neck cancer treated with simultaneous tumor resection and intra-arterial perfusion with nitrogen mustard. This study demonstrated the feasibility of a simultaneous combined approach, with 7 of 10 patients free of disease, 19-46 months after surgery. The small number of cases and lack of staging make it impossible to evaluate these results. The most definitive study of chemotherapy and surgery in oral carcinoma was that of Desprex et al.²⁶ MTX was given intra-arterially followed by surgery three to six weeks after infusion. One group consisting of 28 patients, had complete responses (no clinically detectable tumor present) following infusion. All had good results post-operatively. Analysis of these 28 patients showed that only 4 had positive lymph nodes, 19 were T₁ or T₂ lesions, and 9 had T₃ lesions. While these patients undoubtedly would have responded well to surgery alone, the authors claimed that these patients exhibited improved survival. The second group consisting of 75 patients had residual tumor following infusion. The results of long term follow-up were not significantly better than for surgery alone. These patients initially presented with more advanced disease than the first group; 41 had T₁ or T₂ lesions and 34 were classified T₃. Thirty-five had positive lymph nodes. Despite residual tumor, the infusion did relieve pain, decrease local inflammation, and reduce tumor size by 50-60%.

A few studies have been done which involved all three treatment modalities: chemotherapy, radiotherapy, and surgery. One study²⁷ reported treatment of epidermoid carcinoma of the nasal cavity and paranasal sinuses with MTX and nitrogen mustard via intra-arterial infusion followed by irradiation and radical surgery. Of 45 patients treated, 22 were alive and free of disease for 3-48 months. It is interesting to note that the therapeutic failures died from distant metastases rather than regional recurrence. However, in oral epidermoid carcinomas despite all three modalities being utilized, most patients still succumb to local recurrence.¹⁷

Clearly then, the use of adjuvant chemotherapy combined with the local treatments of surgery and radiotherapy appear not to have significantly altered survival statistics in advanced stage III and IV disease. It does, however, appear to increase the clinically tumor free interval. Whether such combination chemotherapy, surgery, and radiotherapy will prolong survival is too early to tell. Presently, there are well controlled studies being conducted at this institute and others to answer this question.

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A Rational Approach to Adverse Drug Interactions

Norbert R. Myslinski, Ph.D.

ABSTRACT

The field of adverse drug interactions is becoming increasingly more complex and important for the dental practitioner. The tendency is to compile and publish endless lists of drug interactions that are difficult to interpret and lack clinical perspective. The author offers insight into this problem and puts it in manageable form.

A set of principles and guidelines are presented to help the clinician achieve both peace of mind and a rational approach to avoiding adverse interactions. Basic pharmacological mechanisms of drug interactions are summarized.

INTRODUCTION

Undesirable drug interactions have attracted wide attention in recent years. Whenever a patient is treated concurrently with two or more drugs there exists the possibility that they will interact to increase their toxicity or decrease their therapeutic effectiveness (Cowan, 1978; Van Zwieten, 1977). This problem is of practical importance and one in which dentists have more than just an academic interest (Barclay, 1977; Bourgault and Ross, 1976). Much of the population receiving dental care is receiving concurrent drug therapy in the form of prescribed medication or over-the-counter self-medication (Melmon and Morrelli, 1978). A clear professional responsibility exists for the dental practitioner to recognize the importance of these interactions especially those that can threaten life.

Through recent efforts, our understanding of the mechanisms and clinical consequences of drug interactions has increased. Thousands of experimental studies in animals and humans, clinical observations, and epidemiologic studies have been reported. Hundreds of review articles and books on interactions between drugs have appeared during the past decade. It is the purpose of this article to emphasize the importance of seeing adverse drug interactions in their proper perspective, and to serve as a guide in preventing them.*

Despite the numerous studies and publications on drug interactions, many clinicians remain unfamiliar with even the clinically important ones. This situation may be traced back to the lack of clinical relevance that characterizes much of what has been written. Well-intended but uncritical collections of drug interactions serve no useful purpose and have led to confusion. Many of the interactions that are usually mentioned are interesting but of little significance in therapy, and only a few are hazardous. The tendency is to compile and publish endless lists of drug interactions that are based largely on animal experiments or anecdotal clinical reports. In fact many of these putative interactions have not been confirmed in man, have been shown not to occur in man, or lack any importance in the clinical setting (Koch-Weser, 1975). For example, certain lists continue to include meprobamate (Equanil) and chloral hydrate as antagonists of warfarin (Panwarfin). The meprobamate interaction was based on an animal study and has since been shown not to occur in man (Udall, 1970; Gould, Michael, Fisch and Gomprecht, 1972), while that with chloral hydrate is based on an uncontrolled observation of a single patient that has since been disproven (Seller and Koch-Weser, 1970). The importance of interactions should not be overstated (Dollery, George and Orme, 1974).

The avalanche of reports dealing with drug interactions is

* Drug interactions that are planned or therapeutically beneficial will not be discussed.

likely to overwhelm today's dentist. Should a dentist take such lists seriously he would "fall victim to the drug-interaction-anxiety syndrome or even be struck by instant therapeutic paralysis" (Koch-Weser and Greenblatt, 1977). Since simple tabulations of interactions do not stress that many interactions occur inconsistently or vary significantly, they often do not agree with one's clinical experience. They therefore encourage the feeling that the entire concept of drug interactions can be safely ignored.

GUIDELINES

Can a dentist achieve some insight and a set of principles that will help him to attain both peace of mind and a rational approach to this problem? The following four steps are recommended by the author as a reasonable approach to solving this problem in the dental office.

1. *Basic pharmacology*

Develop and maintain a working knowledge of basic pharmacology. A simple awareness of possible interactions, or the use of lengthy interaction tables and charts, are of limited value and possibly even dangerous, since they lead to oversimplification. One should not forget that appropriate understanding of drug action and pharmacokinetics is essential for the correct use of two or more drugs at the same time.

For example, the concept of the therapeutic index is necessary for determining the clinical importance of a large number of interactions. The likelihood or probability of an adverse interaction occurring increases if one or more of the drugs being used has a steep dose-response curve, or small therapeutic index. Many cardiovascular drugs, such as the digitalis glycosides, antihypertensive agents and anti-coagulants have a steep and progressive relationship between dose and response. Consequently, minor changes in intensity of their action can lead to loss of therapeutic control or even hazardous cardiovascular episodes. It is not surprising that cardiovascular drugs appear often in reports of drug interactions.

2. *General Interactions and Mechanisms*

Be aware of the primary classes of drugs that are likely to be involved in interactions, and the general mechanisms of drug interactions. This is feasible and provides a logical framework that fosters the transfer of information to the clinical setting. It should also enable the dentist to recognize previously unreported drug interactions (Solomon, Barakat and Ashley, 1971).

The most important class of drugs involved in potentially disabling or life-threatening interactions are the cardiovascular drugs (Dollery et. al. 1974; Koch-Weser, 1975). This is due to their steep dose-response relationships, their widespread and long term use, and their use in multiple drug regimes. These drugs include the antihypertensive agents, cardiac glycosides, antiarrhythmic drugs and anti-coagulants. Other important classes of drugs involved in interactions are the sympathomimetic amines, anticonvulsants, oral hypoglycemic agents and cytotoxic drugs. Their common manifestations are hemorrhage, cardiac arrhythmias, severe hypertension or hypotension, convulsive seizures and hypoglycemias (Ariens and Simonis, 1977). These are interactions of which any dentist can and must always be aware.

A classification and description of the pharmacological mechanisms of drug interactions is presented later in this paper.

3. *Specific Interactions*

Become especially familiar with the specific interactions of drugs that you use routinely in your practice. The number of drugs that a general dental practitioner uses is relatively small. Specific knowledge of the possible interactions of these few drugs is necessary to prevent those interactions that may not be predictable from general pharmacological principles. There are a number of good publications to which one can refer that critically summarize potential interactions of drugs that a dentist routinely uses (American Dental Association, 1977; Avery, 1977; Cluff and Petrie, 1975; Koch-Weser, 1975; Wynn, 1978).

4. *General Principles*

Follow the recommended principles, given at the end of this paper, for avoiding, or at least minimizing, adverse effects or ineffective treatment as a result of drug interactions. Most of the principles are based on common sense. For example, clinically significant interactions are more likely to occur if large doses are used, if drugs are ingested simultaneously, if therapy is continued for several days or more, or in the presence of associated renal or liver dysfunction.

MECHANISMS OF DRUG INTERACTIONS*

Drug interactions are of two types. The first are pharmacokinetic interactions where one drug alters the concentration of another by modifying its

* The examples in this section were chosen to best exemplify the respective mechanisms of interaction, and are not necessarily of clinical importance for the dentist.

absorption, distribution, biotransformation or excretion. The second are pharmacodynamic interactions which arise from the combination of the actions or effects of drugs.

1. Interactions Involving Absorption

We are all familiar with combining vasoconstrictors with local anesthetic preparations to inhibit systemic absorption of the anesthetic from the local site of administration. Drugs can also interact to influence absorption from the gastrointestinal tract. Many mechanisms are involved but the most significant mechanisms therapeutically are complexation and pH alteration.

a. Complexation

The gastrointestinal absorption of some drugs may be markedly decreased by chelation with heavy metal ions such as aluminum, calcium, magnesium, and iron. Tetracyclines are chelating agents that bind to these metals to form metal-tetracycline complexes which are not absorbed. The effectiveness of tetracyclines can therefore be expected to decline if they are ingested with antacids such as Tums or Roloids, or with Bufferin which contains magnesium trisilicate. Patients must be instructed against washing down the tetracycline capsule with a glass of milk or taking supplemental iron preparations at the same time the tetracycline is administered.

The absorption of fluoride from the gastrointestinal tract can also be significantly reduced by the same mechanism. Calcium fluoride, magnesium fluoride, ferrous fluoride and aluminum fluoride are all insoluble in water and cannot be significantly absorbed into the circulation.

Cholestyramine (Questran), a drug used to bind bile salts within the gastrointestinal lumen, and Kaolin (Donnagel), an absorbent used for the treatment of diarrhea, also bind a number of drugs including some analgesics, antibiotics and vitamins, preventing their absorption.

b. pH Alteration

Most drugs are weak electrolytes which are most readily absorbed through the lipid-containing membranes when nonionized. Ionization is dependent on the pK_a of the drug and on the pH of the drug's milieu. Lowering the pH increases the rate of absorption of weakly acidic drugs and decreases the rate of absorption of weakly basic drugs, and vice versa. Alkaline antacids, therefore, would be

expected to diminish the absorption of weak acids such as phenylbutazone, salicylates, certain sulfonamides and barbiturates.

2. Interactions Involving Distribution

Once a drug is absorbed, an interaction may modify its distribution, or the rate of transfer of the drug from one location to another. Any distribution factors or mechanisms may theoretically be modified by a drug interaction and thereby either enhance or reduce the safety and efficacy of a drug. The most important interactions are those involving competition for plasma protein binding.

Most drugs as they circulate in the blood stream, are present in two forms: free drug and bound drug. Only the free drug can diffuse out of the circulation to produce its therapeutic or toxic effects. The bound drug is pharmacologically inactive and cannot be distributed, metabolized or excreted. This binding of drug to plasma protein, however, is reversible, and the bound drug is in equilibrium with free drug. As free drug is eliminated from the blood, bound drug is released to maintain free drug levels (Vallner, 1977).

If bound drug could be quickly displaced from its binding sites, more free drug would be available to produce an effect. Some dental drugs potentiate the effects of other drugs via this mechanism. Since some drugs are highly protein-bound, displacement of even a small percentage of these drugs from their binding sites can result in a relatively large increase in pharmacological activity. Such displacement is dependent on the relative amounts and affinity constants of each drug for mutual binding sites.

For example, dicumarol is an oral anticoagulant that may be used by some patients for certain thromboembolic disorders. Approximately 98% of the serum concentration of dicumarol is bound to plasma proteins. A dentist may want to give chloral hydrate to sedate a patient who happens to be taking dicumarol. A metabolite of this sedative, however has a strong affinity for plasma protein and would displace some of the dicumarol, producing an increased anticoagulant effect. Decreasing the amount of bound dicumarol by only 6% produces four times as much free drug. Since dicumarol has a low therapeutic index this can result in serious bleeding.

By the same type of mechanism, aspirin displaces the oral hypoglycemic agents, tolbutamide (Orinase) and chlorpropamide (Diabinese), and thus leads to sudden hypoglycemia. Aspirin also removes the anticancer drug methotrexate from its plasma protein binding sites making a highly toxic

drug even more toxic. Other dental drugs that interact by this mechanism include phenylbutazone (Butazolidin), mefenamic acid (Ponstel), and certain barbiturates.

3. Interactions Involving Biotransformation

The body perceives drugs as foreign substances that pose a threat, and normally, but not always, responds by transforming them into substances that are inactive and more easily eliminated from the body. The degree and duration of activity of a drug can therefore be altered by modifying its rate of biotransformation.

The hepatic microsomal enzymes are a primary site of drug biotransformation. The liver has the ability to increase the amount of various enzymes when necessary. Certain drugs that are substrates of the enzyme have the ability to stimulate this increase and thereby enhance their own metabolism and that of related drugs. This phenomenon is known as enzyme induction. Most barbiturates and many other sedative-hypnotics are among the many drugs that are enzyme inducers. If phenobarbital is given to a patient for several days, it could lead to diminished effectiveness of such concurrently administered drugs as phenytoin, digitoxin, corticosteroids, oral anticoagulants and oral contraceptives. Although this effect is fairly reproducible in any given patient, it varies considerably among different individuals. The extent of induction also depends on which specific inducing drug is used, its dosage, and the duration of exposure. Since repeated use over several days is usually necessary for clinically important induction, a single dose of such an inducer, such as a barbiturate, is usually not contraindicated in such patients. Safer therapeutic alternates, however, such as the benzodiazepines, are available.

Another important consequence of enzyme induction occurs when an inducing agent is *withdrawn* from a patient on a maintenance dose of an interacting drug such as an oral anticoagulant. While the patient is receiving the barbiturate the oral anticoagulant is given at a sufficiently high dosage to compensate for the enzyme induction. Since the induction is reversible the microsomal metabolism will return to its slower rate if the barbiturate is withdrawn. Unless the anticoagulant dose is diminished, its plasma levels will become elevated and hemorrhage may ensue (Humminghake, 1970). Caution must always be exercised when either initiating or terminating therapy with an inducer of drug metabolizing enzymes.

Inhibition of drug metabolizing enzymes by drugs is another drug interaction problem. This

type of interaction produces situations which are opposite of those described above for enzyme induction. Monoamine oxidase inhibitors inhibit the enzymes which metabolize a number of drugs including the narcotic analgesic, meperidine (Demerol). As a result of such an inhibition, the levels of meperidine can accumulate and produce depression of respiration and other central nervous system functions.

4. Interactions Involving Elimination

The primary site of drug elimination is the kidney. Changes in the rates of glomerular filtration, renal tubular secretion or reabsorption are all mechanisms of drug interactions. For example, drugs influencing cardiac output or plasma protein binding of drugs can alter the filtration rate and elimination of certain drugs. Some drugs can compete with other drugs and endogenous substances for active secretion into the kidney tubules. Thus salicylates can compete with uric acid and diminish the uricosuric actions of probenecid (Benemid). Interactions involving reabsorption, however, are the most important.

Reabsorption is most commonly influenced by changing the pH of the urine. Any drug that elevates urinary pH, such as sodium bicarbonate, or lowers it, such as ammonium chloride, may have a profound influence on the excretion rates of concurrently administered medications. Drugs that are weak acids, such as salicylates and barbiturates, are more rapidly excreted in an alkaline urine, while weak bases, such as most antihistaminics and narcotic analgesics, are more rapidly excreted in an acid urine. Large doses of over-the-counter drugs such as vitamin C and baking soda, increase and decrease respectively the duration of action of the salicylates and barbiturates.

5. Pharmacodynamic Interactions

This type of interaction involves the actions or effects of drugs. It includes the synergism of drugs with similar adverse effects, and the antagonism between drugs to decrease therapeutic effectiveness. Examples of enhanced toxicity of drugs include the injudicious combination of central nervous system depressants, such as narcotics, alcohol, sedative-hypnotics, tranquilizers and general anesthetics, which may result in serious respiratory depression and hypotension. The ototoxicity produced by the Loop diuretics [i.e., furosemide (Lasix)] is rare when used alone, but a dentist should beware if he adds to it an aminoglycoside antibiotic (i.e., streptomycin) which also produces ototoxicity. Drug induced changes in electrolyte metabolism can also enhance the activity of another

drug. An example is the enhanced toxicity of the cardiac glycosides associated with hypokalemia produced by certain diuretics [i.e., chlorthiazide (Diuril)].

Decreased therapeutic effectiveness is illustrated by the following example of drug antagonism. The administration of a bacteriostatic antibiotic, such as a tetracycline, can render a bacteriocidal drug, such as a penicillin, ineffective. Since tetracycline prevents microorganisms from multiplying, it blocks penicillin which requires multiplying organisms for its effectiveness.

Most pharmacodynamic interactions take place at or near the receptor sites, especially those interactions working on the autonomic nervous system. For example, when two or more chemicals are competing for the same receptors, the extent to which each is bound depends on the quantity of each present and on their relative binding affinities. The cholinergic blocking agent, atropine, elicits no direct pharmacological effect itself, but has a high affinity for some of the receptor sites responsive to acetylcholine. Atropine, therefore, competitively blocks acetylcholine from reaching these receptor sites. Atropine's blockade, however, can be reversed by drugs that allow acetylcholine to accumulate and compete for these sites. These drugs include the cholinesterase inhibitor, neostigmine (Prostigmin), which elevates acetylcholine levels by inhibiting the enzyme which destroys the neurotransmitter (Azarnoff and Hurwitz, 1970).

Another example involves the adrenergic neuron granules that store norepinephrine. Guanethidine (Ismelin) must be taken up into the adrenergic granules before it can produce its antihypertensive effect (Melmon, 1974). A variety of substances interfere with the uptake of guanethidine and thereby reduce its therapeutic effect. Such drugs include amphetamines, ephedrine, antihistamines, and tricyclic antidepressants.

PRINCIPLES

The following are principles that the dentist can use to help avoid adverse reactions (Avery, 1977).

1. *Take a careful medical history of the patient.* Use terms the patient understands to determine his past and present experience with drugs. To obtain missing information you may have to contact the patient's physician or pharmacist, or consult the pictorial code directory of the Physician's Desk Reference.

2. *Do not give a drug unless it is clearly indicated,*

and do not continue a drug any longer than is necessary.

3. *Maintain a working knowledge of pharmacology and important interactions, especially for those drugs that you prescribe with some frequency.*

4. *Consider potential interactions before prescribing drugs.* Keep in mind genetic factors and associated diseases which make an interaction more likely to occur, e.g. impaired renal function.

5. *Communicate with the patient's physician whenever necessary.*

6. *Avoid multiple drug use except where such a combination is pharmacologically advantageous, e.g. decreased side effects, increased effectiveness, etc.*

7. *If concurrent use of two or more drugs is warranted:*

- appropriate monitoring of the patient is mandatory

- avoid drugs with similar side effects

- avoid drugs that have a high likelihood of undesirable interactions. For example, substitute acetaminophen for aspirin, diazepam or flurazepam for barbiturates, etc.

- space doses of drugs a few hours apart, where feasible, to avoid some interactions involving such drugs as cholestyramine and tetracyclines.

8. *Changes of drug therapy should be kept to a minimum.* Many interactions occur when medication is discontinued as well as initiated.

9. *Learn to detect drug interactions* by being alert to increased side effects or any unexplained new symptoms in your patients.

10. *Educate the patient.* Inform the patient of the possible dangers which may arise if he changes his intake of medication, especially of those interactions which can occur between alcohol and other CNS depressants.

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A Research Summary: A Study of Student Value Change and Congruency With Faculty Values in Professional Education

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ABSTRACT

The study of dental faculty and students at the Baltimore College of Dental Surgery, Dental School, University of Maryland supported the hypothesis with qualifications that there is a relationship between student value change and congruency with faculty values. The results of the Allport-Vernon-Lindzey Study of Values Scale showed that a statistically significant student value change occurred on the economic, social, and political value scales. Students' values on the measure were found to be congruent with faculty's values on the theoretical, aesthetic, and social scales. They changed in non-congruent directions on the economic and political scales and remained unchanged and non-congruent on the religious. The findings showed that faculty serve as both a positive and a negative reference group for students. The research also demonstrated that students were found to be selective in areas in which they emulated faculty.

INTRODUCTION

During the 1975-76 academic year, some faculty and students in the Dental School participated in an educational sociological study. Many of those participants expressed an interest in learning the results of the research. This paper, written as an expression of appreciation, is a fulfillment of the promise made by the author to explain the project and share some of the findings with colleagues, students and others who cooperated and were interested in the research.

STATEMENT OF THE PROBLEM

This study, in its broader dimensions, is concerned with some factors which promote or inhibit change in students in professional education. More specifically, it examines the relationships between the concepts of student value change and congruency with faculty values. This paper is part of a larger sociological study on the same issues which utilized a battery of measurements. The results of one of the tests, the Allport-Vernon-Lindzey Study of Values Scales, are the focus of this paper.

The research was undertaken because of the author's belief that the kind of health care people receive has some relationship with the values and attitudes held by the people who provide health services and who structure the health care system. Consequently, the kinds of people health practitioners and health planners are, and the kinds of values and perspectives they hold, impinge on the larger concerns of the kinds of health care people receive, who gets health services, and the ways in which health care is delivered.

There is some evidence to suggest that the attitudes and values of the practitioners, i.e., dentists and others, may be developed and shaped during their professional educational process (Fox, 1957; Goode, 1966; Moore, 1969; Quarantelli, 1959; and Sherlock, et. al., 1972). There is some connection, then, between the input of the professional school faculty who teach them, and the outcome of the students who ultimately deliver service to the patient. This adult socialization and professionalization process forms the basis of this project. The findings of the research contribute to expanding the knowledge in the area of sociology of education. The results have practical applicability for the selection and development of faculty in higher and professional education.

The study explores whether dental students, in their professional socialization process, emulate faculty as their professional role models. It explores whether students' values change during the educational process, and if so, whether there is a significant degree of movement towards the values held by faculty or away from them.

Most students who enter professional schools ultimately graduate as members of their given professions; most medical students become physicians, most dental students become dentists; most law students become lawyers. As stated, the process of professionalization of these neophytes initially occurs during their years of training and study in the professional school. A concentrated, overt attempt is made during those years to infuse the students with the knowledge and skills needed by them to perform their future professional activities. However, the formal and informal socialization processes and influences which help the students internalize the values and attitudes of the profession of their choice are more elusive. The value orientation of a profession is important to the image others have of the profession and to the acceptance of the profession by the public who are the recipients and consumers of the professional services. The attitudes and values of the professional person have some effect on the nature and character of his practice, as well as the manner in which he interacts with patients and clients in the conduct of his professional role.

A wide array of factors impinge on the adult socialization of the student in a professional school. As he moves to acquire and accept the necessary attributes of a professional person in his chosen discipline, the student learns how to integrate these factors. There are psychological, demographic, sociological, and biological factors which the student brings with him when he enters the higher education institution. These include his physical makeup, personality, level of emotional stability and maturity, socio-economic level, familial and cultural background, and general life experiences. These student characteristics have been frequently researched and a range of literature about student values and personal attitudes exists (Learned and Wood, 1938; Nelson, 1938; and Newcomb, 1956).

There are other influencing factors which relate to the professional school as a social system. The ethos of the school system and its component parts and policies may be absorbed by the student as he is exposed to the institutional setting. Among these determinants are such aspects as the school's location and status, its recruitment and admissions policies, the curriculum, the administrative structure, the classroom structure and the patterns of peer interaction.

THEORETICAL FRAMEWORK

The theory serving as the basis of this study is Reference Group Theory. The objective of this

research was to test part of this theory to determine whether it could help to explain values and value changes in students.

Reference Group Theory emphasizes the more conscious aspects of human behavior and relates them to people's participation in group life. This theory assumes that human behavior is to be understood as a process in which the person, through the mechanism of role taking, shapes and controls his conduct by taking into account the expectations of "others" with whom he interacts (Mead, 1934). This theory, as stated in a classic study on medical education, is well adapted to studies concerned with "the interaction of collective behavior and individual conduct where the concepts of interactions" and "expectations are intertwined" (Becker, et. al., 1961).

The "others" with whom he interacts become the person's reference groups. These reference groups may be used as points of comparison in evaluating one's own status; or may be groups to which one aspires to participate or emulate; or may be groups whose perspectives are assumed as one's own frame of reference (Shibutani, 1955). All three of these usages have importance for this study. Obviously, neophytes in professional schools have chosen careers to which they aspire; they desire entry into their chosen professional group. Since professional school faculties are composed largely of members of that particular profession, it can be assumed that the faculty may become an important reference group for the students. Reference groups are related to the idea that one moves toward or away from the acceptance of someone else's value position.

Mead's idea of men "taking the role of the generalized other" has been interpreted as meaning that each person approaches his world from the standpoint of the culture of his group (Mead, 1934). Since he can visualize his proposed line of action from this generalized standpoint and anticipate the reaction of others to his conduct, he can define situations properly, even in the absence of other people. His perspective, therefore, always takes into account the expectations of others. The inference is that Mead was referring not to people, but to perspectives shared with others in a transaction (Shibutani, 1955). This leads to the possibility of expanding the reference group to be "that group whose outlook is used by the actor as the frame of reference in the organization of his perceptual field" (Shibutani, 1955).

Merton extends this idea and develops it more specifically in his phenomenon of "anticipatory

socialization." He clarifies the process by which people selectively develop the skills, attitudes and modes of behavior appropriate to non-membership groups in which they are anticipating, desiring membership, and are likely to enter. The importance and relationship of "anticipatory socialization" to this research and more generally to the field of adult socialization and the process of professionalization cannot be overemphasized. It serves as an explanation of how the student neophytes in dental and medical schools, and in other professions, progress toward professional membership and acceptance and move into professional collegial relationships. It is through the process of anticipatory socialization that aspiring professionals internalize and acquire the values, attitudes, and knowledge and behavior of the desired reference group.

Anticipatory socialization is the mechanism which prepares the individual for future statuses in his sequence of status. Education and training are the explicit aspect of this, but anticipatory socialization focuses on the implicit, informal and unwitting part of this process. This informal preparatory process for roles to be performed has a distinctive character. Merton explains that:

"The individual responds to the cues in behavioral situations, more or less unwittingly draws implications from these for future role-behavior, and thus becomes oriented towards a status he does not yet occupy. Typically, he does not expressly codify the values and role-requirements he is learning" (Merton, 1964).

The present study attempts to provide additional insight into that process in the professionalization of dental students into dentists. Perhaps the dynamics of that process may be better understood if this research finds that these dental students in this particular setting utilize faculty as their reference group to guide their anticipatory socialization process. Movement in student values towards faculty values may not provide a full explanation or necessary proof that reference group theory and the concept of anticipatory socialization are the sole *raison d'être* for the phenomena of professionalization. However, the absence of such movement, or movement in a contrary direction, might suggest that neither reference group theory as presented by Merton and others, nor the notion of anticipatory socialization provide adequate explanation, or that faculty *are not* the primary reference group for most of the values studied. Most students, after all, *are not* aiming to become faculty members. The findings of this re-

search may then help make some necessary theoretical connections. In some small way, therefore, it may contribute to our theoretical knowledge.

In essence, the theory indicates that attitudes, perspectives, and behavior of people are changed and molded by their interaction with others. An explanation of these changes is that they occur as part of the role modeling principle. This is central to the crux of this research.

BRIEF REVIEW OF THE LITERATURE

The influence of the professional school faculty on the professionalization of students has received some attention in the literature, but further documentation and clarification seems needed. The faculty, like the students, can be viewed both as individuals who interact with others on a one-to-one basis, as a sub-group component of the social system, and as a structure of norms, values and roles.

It is assumed, then, that the professional school is an environment where students are expected to acquire both relevant skills and knowledge, and a set of values and attitudes which are broadly characteristic of, and apt, for the profession. Not all students are alike. Students entering professional school bring with them a wide range of attitudes and values deemed professionally desirable, and others which are not regarded as appropriate. Students will be influenced to change their attitudes and values by their peer and faculty contacts to greater or lesser extents and in different kinds of directions.

Medical and dental education are allied professions and there is often overlap. The literature about value changes in students, especially that which relates to medical education, and humanitarian and cynical attitudes pivots around these positions:

1. That the values of students are affected by professional education and that the student changes his values more or less permanently during the training process (Eron, 1955; Gordon and Mensh, 1962; and Christie and Merton, 1958).
2. That the change in students' values is situational to the professional education period and helps students attain their immediate goal of getting through the training process (Becker and Geer, 1958; Fox, 1957; and Reinhardt and Gray, 1972). These studies advance the idea that students revert to their original values when the training period terminates.
3. That the students' values remain virtually un-

changed during their professional education period and students retain the basic values they held prior to school entry (Juan, et. al., 1974; and Hutchins, 1962).

In summary, there is lack of agreement in the medical literature about whether students' values are changed during professional training, about the explanation for the changes which do occur, and about whether the changes are permanent or temporary.

The findings in existing dental research on student value changes are also conflictual. It is difficult to extrapolate clear positions. The predominant theme seems to be that dental students are utilitarian, conservative and pragmatic. (Manhold, et. al., 1963; Heist, 1960; Kirk, et. al., 1963; More, 1962). Other research indicated that dental students move from idealism towards cynicism during their academic years (Morris and Sherlock, 1971; Moody, 1974; Parrish, 1968; and Steinberg, 1973).

A dichotomy of findings on the issue of faculty impact on students and student values is present in both the medical and dental literature. One important theoretical problem is whether student development is in contrast with, or in collaboration with, faculty development (Bloom, 1963). Both positions are supported in the medical education literature (Becker, et. al., 1961; Rezler, 1974; Cohen, 1967; Kendall, et. al., 1957; Christie and Merton, 1958; Hughes, 1957; and Fox, 1957). In the dental education literature less attention has been directed towards faculty impact on student value change but a few related studies have been made (Hollinshead, 1961; More, 1962; Quarantelli, 1961; and Sherlock and Morris, 1972).

METHODOLOGY

The University of Maryland, School of Dentistry, in Baltimore, Maryland was the site of the study. At the time of the research, there were 523 students in the School's undergraduate program; 117 of these were in the 1976 senior class. Ninety-two of these senior students participated in the overall study with 47 of them having comparative 1972 and 1975 available data. The other population in the Dental School who were part of the research were 106 of the School's 229 faculty, of whom 165 were eligible for inclusion in this research.

Hypothesis. "There is a relationship between student value change and congruency with faculty values." The concept of "student value change" was the dependent variable. The concept of "faculty values" was the independent variable.

Operational Definitions. For the purposes of this project, the concepts were operationalized in the following manner:

Students: were defined as the individuals who were included in the School's 1976 graduating class, who had taken the Allport-Vernon-Lindzey (AVL) study of values scale when they entered the Dental School in 1972. This population numbered 51 students. When the A.V.L. was administered again in 1975, 47 of these 51 students participated. However, the total 1975-76 senior class is included in the student population for other aspects of the study.

Faculty: were defined as those individuals with a dental degree who were employed by the Dental School at the time of the research to teach dental students. This includes both full and part-time faculty. No data existed for the faculty prior to the 1975 data collection.

Faculty Values: were defined as the mean of those designated values as measured on the A.V.L. scale. The A.V.L. scale includes six value areas: Aesthetic, Theoretical, Economic, Social, Political, and Religious values.

Value Change: was defined as the difference between the same student's results on the A.V.L. study of values scale in 1972 and in 1975.

Concept of Congruency: was defined as the similarity or difference between the mean values held by students, and the mean values held by faculty on the Allport-Vernon-Lindzey scales and other measures. When the student values are similar to or the same as the mean faculty values, they are labeled "congruent," e.g., student congruency with faculty values. In addition, when student values change and move in the direction of the faculty mean values, they also carry the designation of "congruent." "Non-congruency" occurs when student value change moves further away from the faculty mean values or when the student values are unchanged and are dissimilar to the faculty mean values.

As indicated, the comparison between the 1972 and 1975 Allport-Vernon-Lindzey results for the student who took

this test at both times indicates *student value change*. The comparison of student and faculty results which indicate whether students move closer to or further away from the 1975 values of the faculty was the measure of "student congruency with faculty values."

Description of the Allport-Vernon-Lindzey Study of Values. The data reported in this paper are from only one of the instruments used in the larger study. That measurement, the A.V.L. Study of Values Scale, is recognized as a respected standard testing measure. The same instrument has been utilized in other studies of dental students. However, it has not been used previously in the same way as in this research, which compares the student and faculty values *at a given point in time*. Because previous A.V.L. data existed for some of the dental students, the A.V.L. instrument was utilized in 1975 to obtain comparative data.

As indicated, the Study of Values yields separate scores in six value areas. The test is divided into two parts. It consists of a number of questions based upon a variety of familiar situations to which two alternative answers in Part I and four alternative answers in Part II are provided. There are 120 items in all, twenty of which refer to each of the six values. The data for this measure was tabulated in the intervals suggested in the Study of Values Manual. However, the mean scores were used in the final analysis of the data.

The logic of the study dictated that the issues of change needed to be examined, i.e., change over time and the direction of change. The first step of explanation was to look at change with regard to student A.V.L. values, e.g., in 1972 and 1975. The second step, exploration, was to compare the student and faculty A.V.L. scores in 1975 to ascertain if values changed in the "predicted" direction or not. The third step of elaboration was to control for class rank, to see if one group of students changed more in the direction of faculty than did another group, e.g., top half of the class versus bottom half of the class. The data was also controlled to enable comparisons to be made between younger students and older students on the A.V.L. measurement, between older students and younger faculty, e.g., 28 and 34 years of age, on the A.V.L. scales, between students who held B.A. degrees and other students, and between full and part-time faculty.

Statistical formats and programs were utilized. The major program of operation was the SPSS (Nic, Bent and Hull, 1970). For the descriptive data, e.g., frequencies and percentages, a program code-book was employed. This supplied frequencies,

percentages, means, medians, modes, and standard deviations. For the explanatory phase of analysis, two programs were used, i.e., Crosstabs and Fastabs. Each of these programs supplied the appropriate tables of crosstabulations, chi square values and levels of significance (.05, .01, and .001 were accepted as levels of statistical significance). The t-test for significance of difference was used because the A.V.L. scale scores were considered to be interval data.

Data Collection Process

For Faculty: The initial collection of data from faculty took place in June, 1975, at a Faculty Retreat in Ocean City, Maryland. This was an opportunity to distribute the data collection materials to a group of faculty at one given time. Fifty packets of data were completed and returned on that week-end. The A.V.L. survey was one of several instruments included in the research packet.

It is interesting to note the faculty reactions to the data collection instruments. The opinions about the surveys were of two extremes: many found it fun to do the surveys and made guesses about how they "did"; others were annoyed at the amount of time it took to complete the forms. The average time was about one-and-a-half hours. Even after assurance of the anonymity of their replies, many people needed additional individual reassurance about the confidentiality aspects of the study. Most interesting were the reactions of non-dental faculty at the Retreat who were ineligible for inclusion in the study. Many of them were curious, and some resentful of being excluded. The researcher met and talked with this group about the study. After independently completing their surveys, many faculty bantered about some of the items on the survey. There was a high level of faculty interest.

Those faculty who did not attend the Retreat received their survey packets from their department chairman. Instructions for completion were included in the packets along with a card requesting pertinent demographic data. These packets were distributed in the second week of the Fall quarter. By the time the data collection was terminated in December, 1975, a total of 106 returns had been received out of the 165 faculty who were eligible for inclusion in the study. All data was collected during the 1975-76 academic year.

For Students in 1972 and 1975: The 1976 graduating class numbered 128 students at the start of their first year. Of these, 51 students completed a battery of survey tests when they entered as

freshmen in 1972.* Some of these data, the students' A.V.L. Study of Value scores, were available for comparison with the data collected from the students in 1975. That part of the research utilized a panel research methodology covering a three-year span. *It is the students who participated in 1972 and then again in 1975 who essentially serve as the main student population for the A.V.L. portion of the study.* Of the 117 senior students, 92 participated in the 1975 phase of the study. That figure includes the students who also participated in 1972 when they were freshmen. A comparison of the 1972 and 1975 data is included in this study to show student value change.

The 1972 student data were collected during the Dental School's Orientation Week. At that time, all entering students were given a battery of survey tests as part of a longitudinal attitude study conducted by Morris Roseman, Ph.D., Associate Professor, University of Maryland, School of Dentistry. The tests administered to the students included the A.V.L., as well as other tests. Although the test packets were distributed in a collective classroom situation, the students needed additional time for completing the instruments. Consequently, 47 packets, which were individually returned, were in complete enough form to be usable for tabulation of their results. The students whose data was usable for inclusion in this study were similar to the overall class. They were self-selected on a voluntary basis. These students were not distorted by any special characteristics.

The 1975 student data were also gathered on a collective basis. A two-hour time slot was allotted during the second week of school. An explanation of the research was given to the students. Confidentiality aspects were fully discussed with them. Although the A.V.L. responses of the students who took the measure in 1972 were of special interest in this study, the A.V.L. 1975 data collection included the entire senior class. The majority of the 92 packets were collected at that one particular time. Special efforts were made to follow-up the students for whom comparative 1972 data existed. In addition to the original 1972 sample, another 45 students ultimately returned their information.

In general, the students were interested and cooperative during this process. They needed repeated assurances that the given information was unrelated to their grades and that the opinions they expressed would not be utilized in a way that might

be detrimental to them. It became evident that the personal trust the students had in the researcher whom they knew from repeated classroom and informal contacts, was a positive factor in obtaining the responses. Twenty-five senior students did not attend the data collection session and never indicated any interest in participating in the study.

DEMOGRAPHIC CHARACTERISTICS OF THE POPULATION

Faculty Characteristics. The following demographic information was obtained from the 106 faculty participants in the study:

- a. *Age:*
Average faculty age = 38 years old
Age distribution = 28 years to 66 years of age
41% of the faculty were between 28 years and 38 years of age
Older and younger faculty were found to be generally similar when compared.
- b. *Marital Status:*
3 out of every 4 were married
4% were divorced
6% were single
15% did not respond to questions on marital status
- c. *Sex:*
95% of the faculty were male
5% of the faculty were female
- d. *Employment Status:*
69% were full-time faculty
31% were part-time faculty
The faculty were a relatively stable group: The faculty mean for length of employment in the Dental School = 6 years.
52% had been on the faculty for 11 years or over.
Dispersion ranged from less than one year to 36 years of employment.
In the three-year period covered in the study, 22 faculty who were dentists left the school; 65 new dentists were appointed. Of these 87 changes, 14 are included in the sample population. Of the 106 total faculty included, 92 were in the Dental School during the entire period of the study.
- e. *Academic Rank:*
In the group of full-time faculty, there were:
—7 full Professors
—17 Associate Professors
—23 Assistant Professors
—9 Instructors

* The rest of the class did not complete the survey tests and were not included in this study.

In the group of part-time faculty, where the designation is preceded by the term "clinical" in front of the rank, there were:

- 0 Clinical Full Professors
- 7 Clinical Associate Professors
- 24 Clinical Assistant Professors
- 2 Clinical Instructors

Other faculty ranged from the Dean to research associates and assistants. No differences of significance were found between the full-time and part-time faculty.

f. *Educational Background:*

51% of the faculty had D.D.S. degrees
49% of the faculty had D.M.D. degrees
22% had either B.A. or B.S. degrees in addition to the dental degree

When the data was controlled for faculty educational differences, no significant differences were found.

Student Characteristics. The demographic data for the students are limited both in quality and in scope. The students were requested to fill out a special card giving some background characteristics. No previous demographic data existed in the 1972 student survey. Of the 92 returns in 1975, only 51 students returned the demographic card. Of those who returned the special cards, 48 were males and three were females. All the participants were white. The two students who refused to become involved in the study were black males. No specific reason was given for their refusal other than the fact that participation in the study was voluntary and they did not wish to be involved.

The mean age of the students was 24 years of age. There was an age spread from 23 to 34 years of age. Seven students in the sample were age 30 years or over. Eighteen percent of the students who were 28 to 34 years of age, were in the same range as the younger faculty members. Seventy-one percent of the students were married, twenty-two percent were single and seven percent gave no response to marital status. Eighty-seven percent of the respondents held a Bachelor's degree; twenty-six percent had a B.A. degree and the rest had a B.S. degree.

The students in the senior class came from six states: Maryland, Florida, New York, New Jersey, Virginia and Maine, with the majority (64%) coming from Maryland—the home state. The Dental School has a special exchange program with Florida and fourteen percent of the students came from that state.

No religious information was available for inclusion in this study. An available pertinent variable was students' academic performance. This was measured by the students' class rank. The A.V.L. findings were run against this variable with no significant results. In general, the data suggested that the students were a slightly more homogenous group than were the faculty.

RESULTS

Despite some qualifications, the findings of this study essentially support the hypotheses of the relationship between student value change and congruency with faculty values. Although reference group theory and anticipatory socialization—the theoretical framework of this research—may not be the sole reason d'être for the phenomenon of professionalization, the research supported that a clear association exists between the concepts and the theoretical framework which formed the basis of this research.

Value Change Issue: Analyses of Student Value Change. The findings support the view that student value change does occur during the professional education process. The changes were statistically significant at the .05 confidence level on three of the A.V.L. value scales, e.g., the Economic, Social and Political scales.

Value change has been operationally defined as the difference between the same student's results on the A.V.L. scale in 1972 and 1975. Table One and Chart One summarize the findings for the students who took the A.V.L. on both occasions. However, since all the students were in the same class at the same time and all shared similar experiences, the findings may suggest that basically there were no great differences between the group that took the A.V.L. test in 1972 and those who didn't. The 1972 sample included about fifty percent of the class. It may be possible to look at the students as a larger collective entity than the 47 in the Table, since the findings were much the same when the total 1975 data for the sample of 92 were analyzed. However, only 47 students were used because comparative 1972 data existed for this part of the sample. With this perspective, the results of Table One and Chart One may be applicable to the larger number of students who also took the A.V.L. in 1975, but who did not take the test in 1972.

It is important to indicate in the interpretation of the data that the students, as well as the faculty, fell into the A.V.L. intervals for all other college males. Said differently, the Dental School popula-

Table I. Mean Scale Scores of Student Groups on the Six Allport-Vernon-Lindzey Study of Values

| AVL Scale | Students 1972 | Students 1975 | Significance of Change at .05 Level |
|-----------------------------|------------------|------------------|--|
| Theoretical | 46.9 | 45.3 | NS |
| Economic | 41.7 | 44.3 | S |
| Aesthetic | 39.4 | 41.5 | NS |
| Social | 40.7 | 36.3 | S |
| Political | 41.8 | 43.8 | S |
| Religious | 29.5 | 28.3 | NS |
| Total Number of Students | (51) | (47) | |

tion looked like all other non-medical college males who have taken the A.V.L. measurement. In respect to the six scales, the dental population is similar to student bodies in the other professional schools whose scores fell into the same A.V.L. classifications.

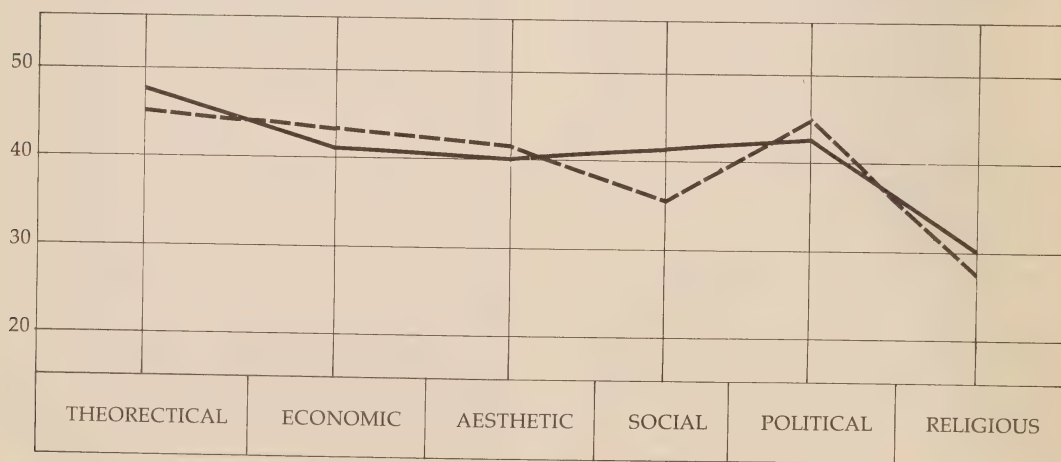
It was possible to have learned that although students accumulated the skills and knowledge of their chosen professional discipline during their four years of professional education and training, they may not have changed significantly in their

value orientations. This possibility is based on the well-accepted assumption that with maturity people's values tend to stabilize and are more likely to remain the same. Since the mean age of the students was 24 years old, with a range up to 35 years of age, this assumption had a good chance of being applicable to this student population. Perhaps, to some extent in cases where no value change was indicated, this assumption may account for the students' value stability.

The most important finding of this part of the

— STUDENT '72
- - - STUDENT '75

Chart I. Comparative Mean Profiles of 1972 and 1975 Student Scores on the Allport-Vernon-Lindzey Study of Values



A.V.L. data, as shown in Table One and Chart One, is that in three of the six value areas the student change was statistically significant at the .05 confidence level. Student value orientations changed on the Economic, Social, and Political scales and remained essentially the same, unchanged, on the Theoretical, Aesthetic, and Religious measures. At issue is whether or not students' values changed because of their educational process. The direction of the change becomes important in relating the movement to the values held by the faculty.

As previously mentioned, A.V.L. scores reflect the relative importance of the labeled values in the life activities of the subjects. The higher the scores, the more important the subjects viewed the value. The A.V.L. Manual also uses the mean scores in the data analysis.

Congruency Issue: Analysis of Student Congruency With Faculty Values on the Allport-Vernon-Lindzey Study of Values Scales. To ascertain the impact of faculty on student change, the critical findings related to whether or not students value changes moved in the direction of the values held by the faculty. When the data on the 1975 student and faculty A.V.L. instrument was analyzed and compared, it was found that the students were congruent with the faculty on the A.V.L. Theoretical, Aesthetic and Social value scales. They changed in non-congruent directions on the Economic and Political scales and remained unchanged and non-congruent on the Religious

scale. Table Two and Chart Two present summary statements of these findings.

Summary of The Allport-Vernon-Lindzey Data on Student Value Change and Congruency With Faculty Values. Table Three is included as an additional summary statement on the findings. This Table is a summary of student value patterns of change between 1972 and 1975 and congruency and non-congruency with faculty in 1975 on the A.V.L. means. This says that students changed their values at a .05 statistically significant level between 1972 and 1975 on three of the six A.V.L. value scales, e.g., Economic, Social, and Political. There was no significant student value change on the Theoretical, Aesthetic, and Religious scales. *Therefore, there is evidence that students' values did change in dental school at a statistically significant level on 3 out of 6 scales.* There was also some lesser movement on the other three scales.

CONCLUSIONS

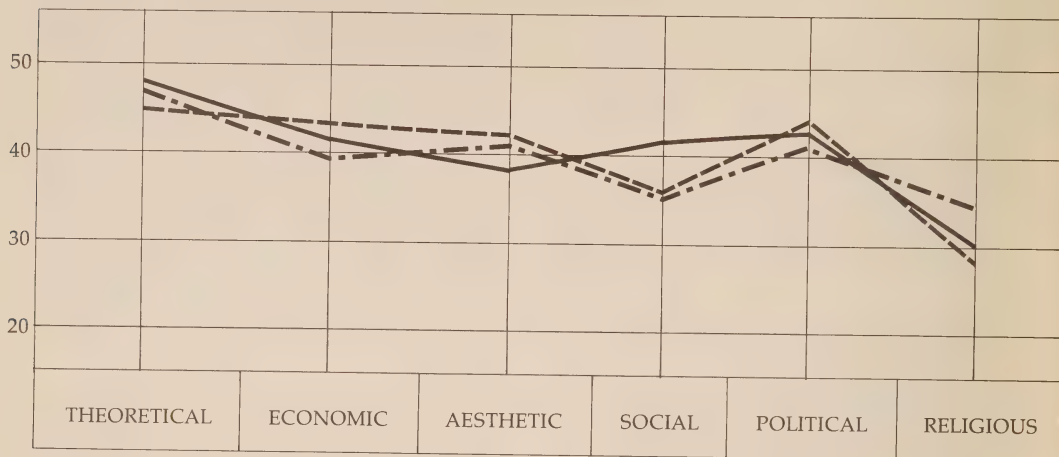
In summary, the hypothesis was verified with some qualifications. Students' values changed to some small degree on almost all A.V.L. value scales during the three-year period covered by the study. The change was statistically significant on the Economic, Social, and Political value scales. Student's values on the A.V.L. measure were found to be congruent with faculty on the Theoretical, Aesthetic and Social scales. They changed in non-

Table II. Comparative Mean Values of Students in 1972 and 1975 and Faculty in 1975 on the Allport-Vernon-Lindzey Study of Values Scales

| AVL Scales | Students 1972 | Students 1975 | Faculty 1975 | Significance at .05 Level Between Students in 1972 and 1975 | Significance at .05 Level Between Students in 1975 and Faculty in 1975 |
|-------------|------------------|------------------|-----------------|--|---|
| Theoretical | 46.9 | 45.3 | 46.3 | NS | NS |
| Economic | 41.7 | 44.3 | 40.8 | S | S |
| Aesthetic | 39.4 | 41.5 | 40.8 | NS | NS |
| Social | 40.7 | 36.3 | 36.3 | S | NS |
| Political | 41.8 | 43.8 | 40.5 | S | S |
| Religious | 29.5 | 28.3 | 32.8 | NS | S |
| N = | (51) | (47) | (106) | | |

— STUDENT '72
 - - - STUDENT '75
 - · - FACULTY

Chart II. Comparative Mean Profiles of Students in 1972 and 1975 and Faculty in 1975 on the Allport-Vernon-Lindzey Study of Values Scales



congruent directions on the Economic and Political scales and remained unchanged and non-congruent on the Religious scales.

Perhaps one of the most significant interpretations of the data is that faculty served as both a positive and a negative reference group for students. The downward movement of the students on the A.V.L. social value towards congruency illustrated that students became similar to faculty in a more negative direction. According to the test results, for instance, students

adopted the faculty's less caring, less loving, and less humane value system toward people. It is also important to note, then, that non-congruency can also imply that the faculty served as a negative reference.

This leads to another important finding, e.g., that students were found to be selective in areas in which they emulated faculty. To purposely decide not to emulate a given value set says that one uses a group as a referent but rejects a particular aspect associated with them. Illustrations of this are the results

Table III. Summary of Student Value Pattern of Changes Between 1972 and 1975 and Congruency and Non-Congruency With Faculty in 1975 on Allport-Vernon-Lindzey Study of Values Scales Based on Comparative Mean Values.

| AVL Scales | Student Value Changes Between 1972-1975 at .05 Significance | Congruency—Non-Congruency Between Students 1975 Values and Faculty 1975 Values |
|-------------|---|--|
| Theoretical | Unchanged | Congruent |
| Economic | Changed | Non-Congruent |
| Aesthetic | Unchanged | Congruent |
| Social | Changed | Congruent |
| Political | Changed | Non-Congruent |
| Religious | Unchanged | Non-Congruent |

on the A.V.L. Economic and Political value scales where students seem likely to differentiate between the values of practicing dentists and teaching faculty and reject the faculty values as inappropriate.

Reference group theory and its anticipatory socialization corollary, which were the theoretical keystone of this study, seemed to be a plausible and realistic framework. Perhaps total negation of the hypotheses in terms of the applicability of reference group theory might have made a more important theoretical contribution than the qualified support of the hypotheses. The research, however, does help make further theoretical connections. Consequently, it adds to theoretical and conceptual knowledge and content in higher professional education.

On a pragmatic level, the findings have applicability for the recruitment, employment, and deployment of professional education faculty as well as being potentially useful in developing and changing student recruitment and admission policies. It is suggested that the faculty member's level of knowledge is but one denominator to be considered by Deans and Administrators. It is possible that a faculty member's beliefs, attitudes, values and behavior may make impacts on students as significant as the acquisition of knowledge and skills.

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Comparison of Methods for Early Identification of Pregnant Mice

Caryl E. Lewis and James L. Hiatt

ABSTRACT

Breeding experiments were conducted on 417 female, Swiss Albino CD-1 mice to evaluate weight gain and the presence of vaginal plugs as parameters for determining pregnancy as early as the ninth gestational day. Positive identification of gravid mice, with a low frequency of false positive selections, was highest when pregnancy prediction was based on presence of a vaginal plug and a gestational weight gain of at least 2g or if no vaginal plug were present, a gestational weight gain of at least 4g.

Often in developmental or teratological research it is necessary to identify gravid animals early in pregnancy in order to obtain fetuses of young gestational age. Determination that mating has occurred in mice is often made by identifying vaginal plugs in the female. Prediction of pregnancy in mice based on the presence of a vaginal plug was reported by Bronson et al.¹ to be high, but strain dependent. In two strains of mice compared by Snell,² 80% to 90% of the mature females which had displayed a vaginal plug were pregnant. Fainstat³ compared the incidence of vaginal plugs with the onset of pregnancy in five strains of mice and found the percentage to range from 14% to 100%. Rugh⁴ reported a pregnancy frequency of 92.4% among female mice which had exhibited a vaginal plug. Although pregnancy cannot be externally diagnosed in the mouse until after gestational day 10,^{5,6} Russell⁵ reported an average weight gain in pregnant mice of 1.4 g, observable on the ninth gestational day.

The purpose of this investigation was to compare vaginal plug identification and weight gain as predictors of pregnancy as early as gestational day nine in Swiss Albino CD-1 mice, and to determine whether a combined evaluation of these parameters might increase the accuracy of early pregnancy prediction and reduce the occurrence of false positive selections.

MATERIALS AND METHODS

Breeding experiments were conducted on 417 Swiss Albino CD-1 mice obtained from Charles River Laboratories. The animals were three to six months of age and were maintained in a controlled environment of 72°F with 12 hour periods of light and dark, alternating at the seven o'clock hour. For breeding, one male was housed with two females at 5 p.m. and removed at 9 a.m. the following day. The latter day was considered day 0 of gestation.

All females were examined for the presence of a vaginal plug immediately after removal of males from the cages. Each female was weighed following examination and again 9, 10, 11 or 12 days after mating. Females were subsequently sacrificed for determination of pregnancy. Vaginal plug and weight data were compared.

RESULTS

The results of breeding experiments with 417 female CD-1 mice are shown in Table 1. Presence of a vaginal plug when used as the sole criterion for prediction of pregnancy resulted in successful identification of 72.8% of the gravid animals. Of those mice which exhibited vaginal plugs on day 0, 3.8% were found not to be pregnant. When criteria for pregnancy prediction were the presence of a vaginal plug on day 0 and a weight gain of at least 4g by the date of pregnancy prediction, false positive selections were completely eliminated. Accuracy of pregnancy

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Table 1. Use of Weight Gain and/or Vaginal Plugs for Identification of Pregnant Mice.*

| Gestational day | No. of females examined | Females displaying vaginal plug on day 0 | | Females gaining at least 4g | | Females displaying vaginal plug on day 0 and gaining at least 4g | | Females displaying vaginal plug on day 0 and gaining at least 2g or females displaying no vaginal plug on day 0 and gaining at least 4g | |
|-----------------|-------------------------|--|-----|-----------------------------|-----|--|-----|---|-----|
| | | %C | %FP | %C | %FP | %C | %FP | %C | %FP |
| 9 | 143 | 76.9 | 2.8 | 88.5 | 2.1 | 65.4 | 0 | 96.2 | 3.5 |
| 10 | 83 | 61.1 | 3.6 | 88.9 | 3.6 | 55.6 | 0 | 94.4 | 7.2 |
| 11 | 113 | 71.4 | 4.4 | 78.6 | 2.7 | 67.9 | 0 | 96.4 | 4.4 |
| 12 | 78 | 80.0 | 5.1 | 100.0 | 3.8 | 80.0 | 0 | 100.0 | 5.1 |
| Total | 417 | 72.8 | 3.8 | 88.0 | 2.9 | 67.4 | 0 | 96.3 | 4.4 |

* Weight gain and/or vaginal plugs were used alone and in combination for selection of mice most likely to be pregnant on each of four gestational days. The percent of those pregnant and correctly selected by each method are compared (%C) with the percent of false positive selections, i.e. those selected but later found not to be pregnant (%FP).

prediction ranged from 55.6% when applied on the tenth gestational day, to 80% when applied on the twelfth gestational day.

The use of weight gain of at least 4g as a lone criterion resulted in correct identification of 88% of the gravid mice but false positive selection of 2.9%. This criterion successfully identified all of the gravid animals when applied on the twelfth gestational day, but gave a false positive selection rate of 3.8%.

When criteria for pregnancy selection were expanded to include females displaying a vaginal plug on day 0 and gaining at least 2g by the date of pregnancy prediction, or females displaying no vaginal plug but gaining at least 4g by that date, the gravidity of 96.3% of the animals could be correctly predicted with a false positive rate of 4.4%. As with other techniques which included weight gain as an indicator of pregnancy, this procedure was most accurate when applied on the twelfth gestational day, but was 96.2% accurate as early as the ninth gestational day.

CONCLUSION

Selection of the most satisfactory techniques for identification of gravid CD-1 mice as early as the ninth gestational day may depend on the size of the animal colony, the time and technical help available, and the economic pressure to reduce the number of animals falsely identified as pregnant. Examination of data on the use of weight gain and/or vaginal plugs for identification of pregnant mice on gestational days 9 through 12 (Table 1) indicated that if only one parameter is to be

employed, selection of mice which have gained at least 4g between conclusion of mating and date of prediction may be most accurate. If elimination of false positive selections is of primary concern, a combination of vaginal plug and at least a 4g weight gain may be desirable criteria.

When the animal colony is relatively small and the experimental design requires accurate identification of the greatest percentage of gravid animals as early as day nine, the most appropriate criteria are the presence of a vaginal plug and a weight gain of at least 2g, or if no vaginal plug were present, a weight gain of at least 4g. The combined use of these two criteria enhances the identification of gravid animals and produces a low frequency of false positive selections.

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A Treasury of Dentistry

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Gardner P. H. Foley.

This "Ode to a Dental Hygienist" was given by Earnest Albert Hooton, Harvard professor of Antropology, as the peroration of his address to the graduating class of dental hygienists at the Forsyth Dental Infirmary in July 1942.

Hygienist, in your dental chair
I sit without a single care,
Except when tickled by your hair.
I know that when you grab the drills
I need not fear the pain that kills.
You merely make my molars clean
With pumice doped with wintergreen.
So I lean back in calm reflection,
With close-up views of your complexion,
And taste the flavor of your thumbs
While you massage my flabby gums.
To me no woman can be smarter
Than she who scales away my tartar,
And none more fitted for my bride
Than one who knows me from inside.
At least as far as she has gotten
She sees how much of me is rotten.

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I. GENERAL INFORMATION

The *Journal* encourages the submission of manuscripts in the areas of dental research, service, and education.

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Each article should be sequentially arranged as follows:

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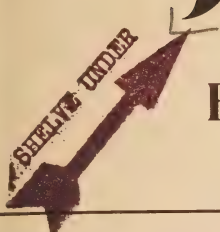
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Cover:

Loops being made in Orthodontic arch wires to increase the flexibility of stainless steel.

PHOTO:

Frank R. Elliott, Jr.



This issue of the *Journal* will regretfully be the last receiving the guidance and direction of Dr. Donald E. Shay, who presently serves as Editor-In-Chief. Dr. Shay, Chairman of the Department of Microbiology and Assistant Dean for Biological Sciences at the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore, will retire on June 30, 1981.

Dr. Shay received the B.S. degree in biology from Lebanon Valley College in 1937. He was awarded the M.S. and Ph.D. degrees from the University of Maryland in 1938 and 1943, respectively. After serving as instructor of microbiology at Muhlenberg College, he became associate professor in microbiology in the Dental and Pharmacy Schools of the University of Maryland at Baltimore. He has been chairman of the Department of Microbiology in the Dental School since 1948.

Dr. Shay published extensively and was the recipient of a National Institute of Dental Research Graduate Training Grant for a 15 year period. He has been active in the American Society for Microbiology, serving as secretary and chairman of the Membership Committee. Besides ASM, Dr. Shay is also a member of the International Association for Dental Research, the American Academy of Microbiology and the American Board of Medical Microbiology.

Dr. Shay has played an extremely valuable role in the development of the Dental School and the University. His dedication and service to the Dental School, to the science of microbiology and the *Journal* are sincerely appreciated. We extend to him best wishes for happiness, health, and good fishing in his retirement.

Mechanical and Clinical Properties of New Orthodontic Alloys

Richard J. Smith, D.M.D., Ph.D.

ABSTRACT

The physical properties of metals that affect their use for orthodontic tooth movement are reviewed. Two new alloys have several features that improve upon stainless steel.

Gradual adoption of these materials by orthodontists over the next decade should result in improved quality of treatment, a decrease in the length of treatment, and greater comfort for the patient.

Orthodontists need an almost impossible combination of mechanical properties from their arch wires. Since all of the materials used for orthodontic wires require compromises of one type or another during treatment, the search for alloys with better combinations of features is an active area of orthodontic research.

The last major revolution in arch wire metallurgy took place in the 1940's, when stainless steel began to replace gold as the material of choice. At the present time, orthodontics may be on the verge of another major change, and it is possible that when the 1980's end, stainless steel will be used for as little as 10 to 20% of the wires in a typical edgewise orthodontic practice. To understand what is happening and why, some basic engineering properties of metal alloys need to be reviewed.

MECHANICAL PROPERTIES

The mechanical features of a metal that are of clinical importance can be described in terms of the basic relationship between stress and strain for that metal. *Stress* is the application of force to an object and is measured as force (such as pounds or grams) per unit area, while *strain*, measured as change in length per unit of original length, is the distortion that the object undergoes as a result of the applied force. Up to a certain amount of force, the relationship between force and distortion (stress and strain) is linear. The slope of this line, that is, whether it is steep or shallow, is defined as the *modulus of elasticity*. With forces within this range of linear response, the object will return to its original shape when the force is removed, exhibiting what is called *elastic* behavior. The maximum force per unit area that can be applied and still allow a return to original form is the *yield strength*. Beyond the yield strength an object will undergo a *plastic* change as it becomes permanently deformed. Eventually, the force will be great enough to break the material.

Within the elastic range, when the applied force is removed, the bent wire springs back, releasing the energy stored during deformation. The amount of energy that the wire can release is a measure of *resilience*. Once deformed beyond its yield strength, however, resilience is reduced. The basic feature of plastic behavior is whether it can be done at all (and how much)—either the material can be bent to a desired shape (such as dead-soft stainless steel ligature wire) or it will fracture (such as glass). This feature is what is known as *ductility* and *brittleness*.

Important for the understanding of orthodontic wires is the fact that plastic behavior and elastic behavior for different metals can be unrelated. A metal with resilient elastic properties can be either brittle or ductile in its plastic range.

CLINICAL PROPERTIES

Within the clinical orthodontic literature, most discussions of wire properties emphasize the attributes of high resilience, a

a low spring rate (or load-deflection rate) and formability (Andreasen and Barrett, 1973; Burstone and Goldberg, 1980; Burstone, 1975; Burstone, Baldwin and Lawless, 1961). Of course, these are in addition to being corrosion resistant, not changing properties or being damaged by temperature or pH changes in the mouth, being non-toxic, having the ability to receive welded or soldered attachments, being of reasonable price and availability, and having a low frictional coefficient, so that teeth can be guided along the wire without the use of high force magnitudes solely to overcome friction.

Resilience has already been defined. It is important because it is this energy that is used to move teeth. As far as resilience goes, the more energy a wire can store, the better.

The second factor of clinical significance is the load-deflection rate. This refers to the relationship between the release of stored energy and the amount of tooth movement. Consider two wires, one with a load-deflection rate of 100 grams per millimeter, the other with one of 20 grams per millimeter. They have equal resiliency, each being able to release 300 grams of force. The wire with the 100 gram rate will have no force left after a tooth has moved 3 millimeters. The patient will have to have an appointment for reactivation. But with a 20 gram rate, the same tooth could move 15 millimeters before the wire loses all force. The result: a longer period between appointments. There is also more room for error with a low load-deflection rate. If an error of 1 or 2 millimeters is made in activation or position of the wire, the high rate spring will deliver a very different force, but the low rate spring will be off by an amount of much less clinical significance.

Finally, a wire needs to be formable, which means that it can easily be shaped and modified with loops or bends as necessary.

RELATIONSHIP BETWEEN CLINICAL AND MECHANICAL PROPERTIES

The three clinical objectives: high resilience, low load-deflection rate, and good formability, can all be described in the formal mechanical terms reviewed earlier.

Resilience is equal to the square of the elastic limit divided by two times the modulus of elasticity (Jastrzebski, 1976). Thus, resilience can be increased by finding a material that can withstand a larger maximum force before being permanently deformed, or one that has a shallower slope to the stress-strain line.

Load-deflection rate, like resilience, can be modified by the addition of loops to an arch wire, or by the type of brackets used, but for any particular configuration, it is directly proportional to the modulus of elasticity (slope of the stress-strain relationship) (Burstone, 1975). Lower load-deflection rates will be found in wires made out of materials with a lower modulus of elasticity.

Formability, the ability to bend a wire to a desired shape, seems to depend to a certain extent on almost undefinable factors that can only be judged by the clinician, but in large part, it is directly related to the ductility of a wire. It is thus a characteristic of the plastic range of deformation, and is unrelated to properties such as the modulus of elasticity or yield strength.

THE NEW MATERIALS AND THEIR IMPLICATIONS

The stainless steel used for orthodontic wires has outstanding formability and no deficit in resilience for delivering working forces for tooth movement. This resilience, however, is achieved because of a high yield strength, and in spite of a relatively high modulus of elasticity (Wilkinson, 1962; Goldenberg, Vanderby and Burstone, 1977). The limitations of stainless steel are related to this high modulus. In order to reduce the high force levels that are found with stainless steel, wires with small diameters are used, which have the undesired side effect of a poor fit in the bracket. Also, loops are bent to lower the load-deflection rate. These require additional chair time, more wire changes, and often increase patient discomfort.

In the past few years, two new alloys have been introduced that alleviate many of the problems of stainless steel. In the early 1970's, George Andreasen and co-workers at the University of Iowa (Andreasen and Hilleman, 1971; Andreasen and Barrett, 1973; Andreasen and Morrow, 1978) reported on the possible use of a nickel-titanium alloy, known as nitinol. Available from the Unitek Corporation, nitinol has become widely used during the past three to five years. Nitinol has the advantageous property of an extremely low modulus of elasticity, under 5 million pounds per square inch, as opposed to about 23 million for stainless steel. Thus, it is capable of large elastic deflections at low force values. The material has, however, some drawbacks. Most importantly, it has low formability, being both difficult to bend and fracturing easily. Also significant is the fact that it cannot be soldered or welded. While nitinol is

replacing stainless steel in many orthodontic practices as the material for the first arch wire or two, when the largest deflections are needed, fewer clinicians have replaced stainless steel with nitinol for the latter phases of treatment.

A newer, and potentially more significant development has been work on a titanium-molybdenum alloy, known as beta titanium and commercially available from the Ormco Corporation as TMA, by Charles J. Burstone and A. Jon Goldberg of the University of Connecticut (Goldberg and Burstone, 1979; Burstone and Goldberg, 1980). The first article describing this material in the orthodontic literature appeared in February, 1980. As of the writing of this review, in August, 1980, it is not yet available for clinical evaluation. If, in actual use, it turns out to be as good as it looks on paper, beta titanium could potentially replace stainless steel for a large part of orthodontic treatment. The modulus of elasticity of the alloy as processed for orthodontic use is 9.4 million, much lower than stainless steel, but somewhat higher than nitinol. Its yield strength is in the range of stainless steel, so that resilience should be excellent. And it appears to have a formability not quite as faultless as stainless steel, but good enough for most clinical manipulations. It also allows successful welds.

In combination, the use of nitinol and beta titanium could decrease the need for loops in arch wires, increase the length of time between appointments, decrease the margin of error between desired and achieved force values, reduce forces on teeth to minimize patient discomfort, and as a result of all these, reduce overall treatment time, shorten individual appointment times, and improve the quality of treatment. There have been other recent major changes in orthodontic technique following from increased strength of directly bonded brackets and the use of preadjusted brackets. It is satisfying to observe that progress is being made: orthodontics in 1990 will be very different from the orthodontics of 1975. The challenge may be to make our understanding of biological factors, such as the retention of completed cases, the control and prediction of craniofacial growth, and the justification for treatment plans, keep pace with progress in mechanical capabilities.

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Histologic Assessment of Pulp Extirpation Methods

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ABSTRACT

The paper describes five methods to obtain intact viable pulpal tissue for histologic and immunologic studies. The methods are evaluated microscopically and the results compared. A satisfactory method is clearly indicated.

INTRODUCTION

The histologic and immunologic studies of pulpal disease require the extirpation of intact, viable pulps. Several extirpation methods have been used with varying degrees of reproducible success. Pomerat and Contino (1) described a method using a separating disk to groove tooth surfaces, then split the tooth with a pliers. Other investigators used a safe side separating disk to groove vertical tooth surfaces using a spray of distilled water to decrease heating effects (2). The traumatic effects of the extirpation frequently effected the histologic characteristic of the pulp while the heat generated by grooving with the separating disk tended to cause pronounced pyknosis and reticular atrophy or autolysis. In this study, various methods of extirpating intact, potentially viable pulps were studied in order to develop a method which gives minimal tissue distortion.

MATERIAL AND METHODS

Collection of Teeth

Single rooted human teeth were used (i.e., maxillary and mandibular central incisors, lateral incisors, canines, and premolars with the exception of maxillary first premolars). The teeth were extracted in the oral surgery clinic at the University of Maryland Dental School and were placed in RPMI-1640 with Gentamycin (100 mg/ml) (GIBCO, Grand Island, N.Y.) immediately after extraction. The teeth were refrigerated (4 degrees C) until used. The teeth were usually used within 7 days of extraction. Some pulps were to be fixed at a specific time following extraction.

Methods of Splitting Teeth

Method 1: The first method was to place a tile cutter along the long axis of the tooth and apply moderate pressure.

Method 2: The second method was to first place 3 grooves on the tooth using a diamond disk on a belt driven handpiece on the tooth using a diamond disk on a belt driven handpiece (i.e., low speed). One groove was placed on each proximal surface to a depth of 1-2 mm. These grooves were along the long axis of the tooth and along the midline of the surface. The third groove was placed so as to connect the proximal grooves. The tile cutter was then placed on the tooth so that the applied force to split the tooth was approximately at the junction of the upper $\frac{2}{3}$ of the root.

Method 3: The third method was identical to the second method except that the grooves were placed using a high speed diamond disk and water spray.

Method 4: The fourth method was to groove the buccal and lingual surfaces rather than the proximal surfaces. One groove

was placed on each surface to a depth of 1–2 mm, along the long axis of the tooth and along the midline of each surface. The third groove was placed on the incisal or occlusal surface to a depth of 3–4 mm so as to connect the buccal and lingual grooves. The grooves were placed with a high speed diamond disk and water spray. Again, the tile cutter was placed on the tooth so that the applied force to split the tooth was approximately at the junction of the upper $\frac{2}{3}$ of the root.

Method 5: The fifth method was to groove the tooth approximately 1 mm below the cemento-enamel junction, completely around the tooth, to depth of 1–2 mm. The groove was placed with a high speed diamond disk and water spray. The tile cutter was then applied to split the tooth into two fragments.

Histology

Once the tooth was split into two segments, exposing the pulp, forceps were used to free the pulp from the underlying dentin. The pulp was then grasped at the apical end with the forceps and removed from the tooth. At times some dentin remained over the apical pulp tissue. This was chipped away with the forceps in order to remove the pulp. Also, a Bard-Parker knife was used to free the pulps from the apex of the root canal, when needed.

The pulp tissue was formalin fixed (10% NBF) and processed in the routine manner in an auto-technicon (3) (Formalin—80%, alcohol—100%, alcohol-xylene-toluene/paraffin). The paraffin embedded tissue was sectioned on a rotary microtome at 6 microns and stained with hematoxylin and eosin. The coverslips were placed with permount.

The tissue specimens were evaluated microscopically and graded on a scale from 1 to 4:

- 1=optimum preservation of pulp tissue (Fig. 1)
- 2=slight pyknosis of odontoblasts
- 3=pyknosis and necrosis of fibrous connective tissue
- 4=pyknosis and reticular atrophy or autolysis (Fig. 2)

RESULTS

Cleaving of Teeth

Method 1: Splitting teeth without placing any cleavage grooves. In the first attempt, a mandibular cuspid fractured into four sections. In the second attempt, a mandibular first premolar fractured into two pieces exposing only a part of the pulp. In the

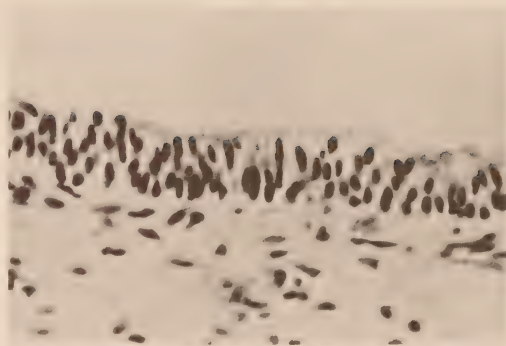


Figure 1: Photomicrograph showing well fixed intact odontoblasts, histologic grade 1.

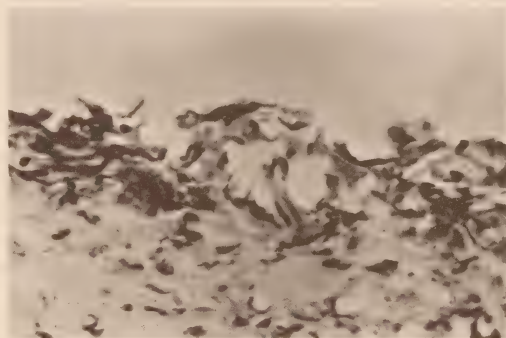


Figure 2: Photomicrograph showing pyknosis and autolysis, histologic grade 4.

third trial, a mandibular cuspid fractured into three pieces. In the fourth trial, not enough force could be applied to split a maxillary cuspid. Splitting the teeth without first grooving them not only required more than moderate force, but resulted in fracturing the teeth in an unpredictable manner.

Method 2: Splitting teeth with three cleavage grooves placed with a belt driven diamond disk on the occlusal and proximal surfaces. This method was found to result in a predictable split along the pulp chamber and canal. With seven experimental series, five resulted in the pulp chamber being completely exposed, while twice a small amount of dentin remained over the tissue at the apical $\frac{1}{3}$ of the root. These bits of dentin were chipped away with a forcep or thinned first with the diamond disk and then chipped away. The pulps were easily removed. This method gave better predictability than Method 1, in terms of cracking the teeth and isolating the pulps. However, two major problems were noted. First, because the teeth were cut dry, a tremendous amount of "tooth dust" with a pronounced odor

characteristic of burning tooth surface was produced. This was bothersome to the technician despite the use of protective glasses, gloves and surgical cap. Also dry cutting produced a noticeable amount of heat which is undesirable in a study of pulp tissues.

Method 3: Splitting the teeth with three cleavage grooves placed with a high speed diamond disk and water spray on the occlusal and proximal surfaces. This method was also found to result in a predictable split along the pulp chamber and canal (Fig. 3). The pulps were easily removed and showed no visible damage from the splitting procedure. Eleven teeth were grooved and split in this fashion with satisfactory results.



Figure 3: Typical example of a tooth split via method 3.

The use of the water spray served to reduce or eliminate the undesirable effects seen with "dry cutting." The water spray prevented a large amount of "tooth dust" from escaping into the surrounding environment. It also greatly reduced the amount of heat generated while placing the cleavage grooves. With less heat, the offensive odor was decreased to a minimum as well as any adverse effects to the pulpal tissue.

Method 4: Splitting the teeth with three cleavage grooves placed with a high speed diamond disk and water spray on the occlusal, buccal and lingual surfaces. This method resulted in a predictable split along the pulp chamber and canal in the maxillary central incisor and in the mandibular first premolar. The pulps were removed easily and were intact. Splitting mandibular centrals in this direction, however,

resulted in their fracturing into more than two pieces.

Method 5: Splitting teeth with a continuous groove placed with a high speed diamond disk and water spray, 1 mm below the CEJ. In this method the teeth were easily and predictably split into two sections. The pulp was freed from the coronal section of the tooth while remaining in the apical portion. Forceps were used to grip the coronal pulp tissue and pull the entire pulp out of the tooth. This method of grooving and splitting the teeth is probably the quickest and easiest of all. However, the pulp tissue would either come out only with excessive force or would tear, leaving tissue in the tooth. Pulps that were removed in one piece appeared histologically disoriented and distorted. Therefore, upon final analysis Method 3 was found to be the most reproducible method for splitting teeth and obtaining intact pulps.

Effect on Pulp

The pulps from the six teeth that were split using Method 2 were fixed, processed, sectioned, stained and graded as previously described. All six specimens were given the histologic grade of 4. (Table 1). Of the six specimens, four showed either partial or total autolysis. This would indicate that the tissue culture medium did not infiltrate adequately through the apex of the tooth to preserve the viability of the pulp tissue. The other two specimens also showed signs of coagulation necrosis indicating the heat generated by the low speed diamond disk directly affected the pulp tissue. Indeed the two specimens were taken from mandibular central incisors which have the least amount of hard tissue to act as insulation for the pulp.

The pulps from the six teeth treated by Method 3 were also examined histologically. Two specimens were given a grade of 2. Two were given a grade of 3, and two were given a grade of 4 (Table 1). The specimens receiving a grade of 2 were mandibular central incisors. They demonstrated some pyknosis but didn't demonstrate effects from heat. This would indicate that using the high speed diamond disk with water spray is the preferred technique for placing grooves. The specimens that were given a grade of 3 showed some breakdown of fibrous tissue and pyknosis, probably due to the inability of the culture medium to diffuse through the root apex. The specimens given a grade of 4 showed reticular atrophy. Perhaps this was due to some water contamination and is actually hydropic damage.

TABLE 1
COMPARISON OF HIGH AND LOW SPEED ON PULPAL TISSUE

| Low Speed | | High Speed | |
|-------------------|------------------|-------------------|------------------|
| Histo Observation | Histo Evaluation | Histo Observation | Histo Evaluation |
| Max central | 4 | Max central | 3 |
| Max central | 4 | Mandib cuspid | 3 |
| Max central | 4 | Mandib central | 2 |
| Mandib central | 4 | Mandib central | 2 |
| Mandib central | 4 | Max central | 4 |
| Max canine | 4 | Max central | 4 |

One of these pulps (from the maxillary lateral) also showed some effects from heat.

Since the amount of time the teeth were left refrigerated in the culture medium appeared to be an important variable, ten teeth were grooved and split via Method 3, at a known time after extraction. The pulps were fixed and evaluated microscopically. Nine out of the ten specimens were shown to deserve grades that were directly related to the amount of time the tooth was stored in the culture

medium. From ten minutes to three hours after extraction, six out of the seven specimens were excellent, receiving a grade of 1. Only one specimen in this category received a grade of 2. The three specimens that were split and fixed 24-29 hours after extraction were given a grade of 2 (Table 2).

The pulps from the three teeth that were grooved and split via Method 5 were given a grade of 4. All three specimens were disoriented and distorted.

TABLE 2
EFFECTS OF TIME ON PULPAL PRESERVATION

| Time | High Speed | |
|-------------|---------------------|------------|
| | Observation | Evaluation |
| 10 minutes | Mandib incisor | 1 |
| 10 minutes | Max lateral | 1 |
| 35 minutes | Mandib cuspid | 1 |
| 1 hour | Mandib premolar | 1 |
| 2.5 hours | Mandib lateral | 1 |
| 2.5 hours | Mandib canine | 2 |
| 3 hours | Mandib 1st premolar | 1 |
| 24-29 hours | Mandib premolar | 2 |
| 24-29 hours | Mandib canine | 2 |
| 24-29 hours | Mandib central | 2 |

DISCUSSION

The purpose of this study was to develop a method for obtaining viable pulpal tissue with minimal tissue distortion or damage. Several previously described methods were evaluated with histologic parameters (1, 2, 4). Modifications of these methods and the effects of time between extraction and fixation were included in this study. The extracted teeth were stored in tissue culture media until the pulps were removed and formalin fixed.

The only method which consistently produced satisfactory results was method 3. Using occlusal and proximal cleavage grooves placed with a high speed diamond disk and water spray, we obtained the best preservation of normal histologic detail. Method 1, utilizing a tile cutter without cleavage grooves, required excessive physical pressure and produced an unpredictable split. Using low speed (Method 2) to cut cleavage grooves generated excessive heat. The pulpal tissues exhibited coagulation necrosis secondary to the thermal injury. Occlusal and buccal lingual cleavage grooves (Method 4) yielded satisfactory results in some teeth, but this method was not suitable for all teeth. With the exception of maxillary centrals and laterals, pulp chambers are basically oval rather than round in a buccal-lingual direction so that grooving and splitting the tooth along the proximal surfaces results in a better chance of splitting the tooth in the vicinity of the pulp tissue. The tooth's hard tissue (i.e., dentin, enamel, cementum), is wider in the B-L direction and grooving and splitting the teeth along the proximal surfaces results in two thick manageable fragments, rather than many fractured pieces. Also the root dimensions are wider bucco-lingually than mesio-distally and placing the tile cutters on the proximal surfaces lends itself to a parallel application of force, along a wider section of root and a more predictable split. Mandibular incisors are particularly small and subject to fracture, so it is understandable why it was noticeably better to split these teeth along the proximal surfaces rather than along the B-L surfaces. Removing the crown and teasing out the pulpal tissue (Method 5) produced considerable distortion due to the required soft tissue manipulations.

The histologic findings indicated that time is a critical factor if the goal is preservation of the entire pulp. Specimens left in culture media for more than three hours showed foci of necrosis and areas with pyknotic odontoblasts. The pyknosis and necrosis

was usually in the coronal portion of the pulp. These findings are more likely due to anoxia. It appears that the culture media cannot reach the coronal pulpal tissue. Removal of the narrow apical portion of the tooth may solve the problem. However, if the goal is preservation of the entire pulp, a three hour time limit must be accepted.

We have presented a consistently reliable method for obtaining pulpal tissue with minimal tissue damage or distortion. Occlusal and proximal cleavage grooves cut by high speed diamond disks with a water coolant followed by gentle cleavage with immediate fixation was the only suitable method. Extracted teeth may be stored for up to 3 hours in tissue culture media.

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The Accelerated Professional Training Program— An Alternative Method of Dental Education

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ABSTRACT

The Accelerated Professional Training Program is described. A review of its development and discussion of its major curricular modifications are presented. An analysis of some of the advantages of such a program are suggested as well as student reaction and attitudes.

During the 1960's and early 1970's, dental literature was strongly suggesting the existence of a shortage of practitioners and auxiliaries in the United States. Indeed, manpower surveys were revealing deficiencies throughout the health sciences.^{1,2,3,4,5,6} Consequently this issue became the subject of extensive discussion and evaluation and lead to the development of specific efforts which would address the concerns as well as establish programs for the better utilization of dental personnel. The federal government offered the incentive of financial support to dental schools in the form of capitation grants for increased enrollments plus additional funds for the earlier graduation of students. Concurrently, several schools were examining the possibilities of significant alterations in curriculum design which might not only speed up the educational process but also make it more relevant to the students.^{7,8} One unique area of curricular modification was the transition of several four-year programs into three calendar year tracks. In 1970, only one dental school in the United States offered such a program. However, by 1975, it was possible to receive a D.D.S. or D.M.D. degree within three years from 16 institutions.⁹

There were reasons other than the more rapid production of qualified graduates for establishing three-year programs. Decreasing the cost of education to the student, more efficient utilization of clinic and laboratory facilities, and increasing clinic income were all believed to be added benefits for such a transition. Regardless of this, the primary means by which it was accomplished was the condensing of a basically unaltered four-year curriculum into a continuous 32 or 34 month period,^{10,11} and this condensation eventually created many concerns as to the quality of the educational process and the development of an even more pressure-packed environment for both students and faculty. As a result, and also due to re-evaluation of manpower requirements, by 1978 only five schools retained this concept.¹²

In 1971, a three academic year curriculum track was also proposed at the University of Maryland Dental School. While it would be a means of qualifying the School for funds available through the various federal programs, its primary function would be that of an experimental model in dental education.¹³ Designed as a separate unit from the four-year program, class size was limited to ten students. The administration selected three faculty members as a core teaching group and charged them with the responsibility of developing and maintaining a program which would stress the individualization of instruction, utilization of independent study and self-pacing techniques, and would provide the clinical exposure necessary to adequately prepare a student in all aspects of general dentistry. This

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Accelerated Professional Training Program, through the development of its educational goals, established a philosophy of course content and sequencing which shaped it into a course of study unique from other three or four-year curriculums.

The program was, and continues to be, centered around a disease-oriented curriculum as developed by a faculty of practicing dentists with strong basic science backgrounds. The primary topics of caries, periodontal disease, and malocclusion provide the foundation from which the diagnosis, prevention and treatment aspects are developed. Accordingly, several of the biologic sciences have been grouped together under a few major subject areas and integrated through a pattern of behavioral (learning) objectives that provides for a continuity of information. Typical departmental boundaries were re-organized. As an example, the topics of anatomy, physiology and biochemistry have been coordinated into the course Essentials of Human Biology while microbiology and pathology have been condensed into the unit Mechanisms of Disease. These subjects were developed and are continually revised in relation to their relevance and support of clinical practice. Thus, by a process of selective elimination, significant amounts of material found in traditional dental curriculums have been removed in APT, mostly from the basic sciences.

The primary methodology of didactic instruction in APT is through the use of teaching conferences or seminars. Each one is devoted to a specific lesson plan and is based upon textbook references and audiovisual learning sources. Through specific behavioral objectives, a framework for the interchange of information between faculty and students has been established. This approach emphasizes the self-instructional basis of the program as these meetings are largely not in lecture form and the students are expected to contribute to the direction that each session takes.

Another major facet of teaching methodology is the reduction in pre-clinical technical experiences. In comparison to the four-year program at Maryland, as much as 70% of the time designated for basic dental exercises has been eliminated. This approach is based on the concept that clinical proficiency is gained more rapidly in a clinical environment than in the laboratory. Many procedures that are clinically reversible, in the sense that tissue removal is not involved, have been significantly reduced or eliminated from pre-clinical efforts. However, students must demonstrate adequate proficiency in the various types of dental restorations and endodontic

procedures before they are allowed to perform similar operations on clinic patients. The system has proved successful but is dependent upon the supervision and strong support of the faculty. Those faculty members who teach the laboratory experiences also supervise in the clinic in order to provide a smoother transition and guarantee a continuity of theory for each procedure.

The sequencing of the curriculum to allow for the earliest possible exposure to clinical experiences is an essential element of APT. The self-instructional aspects of the program, together with the reductions in curriculum material, have contributed to a significant savings in time and provided the means by which this is accomplished. It has been stressed by many educators that rapid progression into the clinical environment provides an invaluable increase in motivation for the dental student.^{14,15,16} In APT, the first year students are immediately scheduled to assist upperclassmen in periodontal surgery and hard and soft tissue charting and are encouraged to observe and participate in as much clinical activity as possible. Complete denture patients are assigned to them at the beginning of the second semester and by late spring they receive comprehensive care patients and begin treatment planning and performing initial periodontal procedures and various restorative techniques. By scheduling seminars on basic forms of therapy early in a course, these students can begin to work with patients before the course is finished, thereby reinforcing didactic work through immediate clinical application. This method of sequencing provides a framework for later instruction and is another strong motivation tool.¹⁷ As an added advantage of the early clinical exposure, APT students are provided with more scheduled hours of clinical exposure than are the four-year students.

The APT Program has several significant advantages in comparison to other dental programs, related specifically to its small class size and student selection process. These aspects cannot be over-emphasized. Because there are no more than twenty students engaged in full-time clinical activities, the faculty has more intimate control over student development and the progress of individual cases; greater accuracy in student evaluation is possible. The size also provides for a more relaxed atmosphere in the clinical area and student-faculty relationships are further improved due to the informality of the didactic and laboratory teaching environments. Much of the success of the program must also lie with the students themselves. Selected

for their maturity and potential ability to function well independently, a sense of group purpose and cooperation among them has become stronger as the program has developed and individuals who confront difficulties are assisted and encouraged by their classmates. These advantages have all contributed greatly to a positive learning atmosphere which is so much a part of the APT philosophy and have directly lead to the formulation of student attitudes which attest to the importance of such an environment. Most evident within the classes is the high regard that is held for APT and the school itself; a very important factor when compared to the negativism produced by some traditional curriculums. Through the elimination of considerable amounts of frustration and boredom, a very positive attitude has been developed in relation to the educational process. The learning experience has not become simply a means to an end, i.e. graduation, but a valuable contribution to the development of a professional and the initiation of the lifetime requirement of continued intellectual growth.

Constant re-evaluation and re-organization of the curriculum plus periodic changes in faculty assignments have greatly altered APT from its initial design. While the basic concepts and goals of the program remain unaffected, more and more support from the four-year program has been required and thus less control of course content remains with the core faculty. Although no longer a primary objective, the curriculum continues as a three-year format. Recently, however, much emphasis and consideration has been aimed at lengthening the program so as to incorporate new ideas and increase clinical exposure for the students.

The Dental School administration is supporting the APT Program as an on-going laboratory in which more effective methods of dental education may be tested in a sheltered environment. It is anticipated that the conventional four-year curriculum will benefit from what is learned in APT through a gradual, evolutionary process. The rotation of other faculty through the program will further enhance this process and will also ensure that the curriculum content remains up-to-date. Although this "school within a school" has satisfied a long-standing federal requirement for increased enrollment, it has also served as a unique method of educational research, wherein lies its future promise.

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Mandibular Displacement During Mastication

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ABSTRACT

A literature review of the techniques utilized to assess functional mandibular movements is presented. Though past research has been valuable, some limitations are apparent.

In addition, few studies have examined the development of mastication. Recent studies have utilized computer technology.

These technologic advances may help develop new criteria for clinical definitions of normality.

INTRODUCTION

The path of the human mandible during mastication and/or specified movements has been examined by a variety of techniques. Studies of jaw movement have examined variables such as muscle activity and interocclusal forces while utilizing supplemental information such as study casts and cephalometric records.¹ This review will discuss the usefulness and limitations of some of the methods employed in studies of human mandibular movement. Future directions of this area of research will also be considered.

EARLY STUDIES

Since Hildebrand's² study of the movements of the mandible during mastication, several investigations have attempted to analyze human masticatory function. These investigations³⁻¹⁰ include: 1) studies of occlusion, mandibular position and patterns of mandibular movement, 2) synchronized analysis of muscular and skeletodental components of the masticatory system during function and 3) studies of muscle activity alone. In the first two types of studies, a method for tracking the movement of the mandible was necessary.

Posselt's³ study of mandibular movement provided information concerning the border limits of mandibular position in adults. He described an "envelope" of mandibular motion which was highly reproducible in individual subjects. With the exception of studies examining tooth contact, most research in mastication since Posselt's classic treatise has examined mandibular movements within the envelope.

Beyron⁴, in a longitudinal study which included oral examinations of occlusion, articulator analysis of occlusion and observation of mandibular movements, suggested that mandibular movement patterns were determined by factors related to the occlusion. Beyron⁴ considered the most important factors to be the person's original tooth position and occlusion. He classified adolescent and adult subjects according to their predominant movement patterns, and noted that the resulting groups did not correspond to accepted classification of occlusion, i.e., Angle's classification. Functional classification did not correlate with clinical classification. Beyron⁵ later examined masticatory movements on analytical tracings from cinematographic records and described a masticatory cycle with a wide, oval form.

The oval masticatory cycle was analyzed in more detail by Murphy⁶. He evaluated cinematographic records of a single subject using a frontal view motion picture technique twice as fast as Beyron's technique.⁵ From tracings of the subject's incisor movement*, Murphy concluded that jaw movement during

*Beyron⁵ and Murphy⁶ both observed incisor movement directly; their Aborigine subjects chewed with their lips apart.

mastication had a regular pattern with variations sometimes occurring within the pattern. He subdivided the oval masticatory cycle into six phases: Preparatory, contact with bolus, crushing, tooth contact, grinding and centric occlusion. The final three phases, which comprised 20% of the total cycle, involved intercuspal contact. Murphy suggested that the path of the mandible in the final phases of the masticatory cycle corresponded to the inclinations of first molar occlusal anatomy. He implied that masticatory function was dictated by occlusal form; an important consideration in the restoration of occlusion.⁶

Ahlgren⁷ also used direct cinematography in a study of thirty-five school children, aged 9-16. Frontal and sagittal movements were recorded on film by tracking the movement of a small device attached to the mandibular incisors. Only the frontal movements were reported. Seven chewing patterns, none oval, were noted. Of the seven patterns, Ahlgren considered three teardrop shaped chewing patterns to be normal. Though he noted the Angle classification of his subjects, he did not correlate this classification of occlusion with functional movement patterns until later.⁸

In this new study, Ahlgren⁸ gathered subjective data by direct observation on the pattern, rhythm and direction of masticatory movements from three-hundred and twenty, 8-16 year-old children. As Beyron⁴ had noted earlier, no correlation between pattern of chewing and classification of occlusion was found. It was observed, however, that children with malocclusion of their teeth most frequently exhibited a chopping stroke, while subjects with "normal occlusion" had more regular and consistent movements.⁸ Variations in the form of an individual's masticatory movement were also noted, in agreement with earlier studies.^{5,7}

Ahlgren⁹ also combined electromyographic and cinematographic techniques to study masticatory function in ten, 8-15 year-old subjects. Frontal view motion pictures were again utilized to record the movements of a protruding bar attached to the mandibular incisors while simultaneous electromyographic recordings were made of the masseter and temporalis muscles. Both Ahlgren's^{7,8,9} and Møller's¹⁰ electromyographic studies have produced reliable data for a variety of parameters related to mastication.¹¹ From these studies an overall pattern of masticatory muscle and movement activity has been described, though variations in these movement patterns and muscle activities can occur from one chewing stroke to the next.⁷⁻¹⁴ Limitations in

the cinematographic techniques of the early studies were, however, evident.

Ahlgren^{7,8} noted the film speed of his early study and the technique of direct observation lose detail because of cinematic limitations and/or the inherent high speed of mandibular movement. In addition Hiimae¹⁵ noted that the use of interrupted recording techniques*, such as cinematography or cinefluorography, results in significant diminution of resolution during tooth to tooth contact. The photographic samples recorded by these techniques generally demonstrate poor visibility.¹⁵ Problems with the cinematographic technique including the limited resolving capabilities, the expense and the time necessary to analyze film frame by frame, inspired researchers of masticatory behavior to refine their investigative armamentarium. This trend to improve the study of mandibular movement may be seen in the work done since 1970 which will now be described.

Gillings, Graham and Duckmanton¹⁴ recorded specific jaw movements in twenty-two adult men by using a photoelectric mandibulograph. Though they found considerable subject to subject variability, the mandibular movement patterns of individual subjects appeared to be regular and repeatable. This repeatability of movements from one chewing cycle to the next had not been seen in earlier studies.^{5,6,7,8} A new technology had been utilized, but an old conclusion was reached. Movement patterns of the mandible could not be predicted from analysis of occlusal classification.^{4,8,14}

Gibbs, Suit and Benz¹⁶ used a system which included a gnathic replicator, tape recorder and computer to study masticatory movements of the mandible in frontal and sagittal planes. Twenty-two adult subjects exhibited teardrop shaped mandibular movement patterns in both planes of space. These investigators found that an inverse relation existed when sagittal and frontal angles of approach in jaw closure were plotted. The flatter the closing approach appeared in the frontal path, the steeper it appeared in the sagittal view.¹⁶ These investigators suggested that the relationship of anterior and posterior angular determinants of closing approach be incorporated into clinical treatment when establishing harmonious occlusion.¹⁶ They suggested that the investigative technology they had used should be applied to clinical care because a full range of accurate functional movements, between

*Interrupted recording techniques such as cinematography "sample" jaw position at regular intervals. Continuous recording gives a record of the continuous variation of jaw position.¹⁵

lateral extremes, could be reproduced on their apparatus. These functional movements were considered to be dictated by occlusal anatomy and interocclusal relationships.¹⁶ New technology was being advised for clinical care.

Electromagnetic devices for monitoring three-dimensional linear movement of the mandible, were developed and utilized clinically and in research in recent years.^{11,17,18,19,20} One device, the commercially available Mandibular Kinesiograph*, senses the spatial location of a magnet mounted in the mandibular incisor region.¹⁷ The kinesiograph system consists of an array of magnetometers which measure the strength of the magnetic field. The position of the magnet can be sensed in three planes of space.^{17,20} The magnetometers are situated on a lightweight aluminum frame supported by a spectacle-like device worn by the subject.^{17,20} This system provides a noninvasive technique for measuring jaw displacement. Unlike the other systems discussed, the kinesiograph could be applied to collecting data from large numbers of subjects.²⁰ The kinesiograph could display time varying measurements for each dimension of mandibular movement and input this data to a computer for processing or to a magnetic tape recorder for storage and subsequent analyses.^{11,21}

Hannam *et al*¹⁹ used a computer based analysis system, incorporating the kinesiograph, to describe mandibular paths and electromyographic patterns of patients before and after occlusal equilibration. It had been believed that peak elevator muscle activity should occur at or near the intercuspal position.^{22,19} If this were true, occlusal adjustment was expected to shorten the interval between peak elevator muscle activity and the occlusal position of the mandible during closure. Indeed, Hannam *et al*¹⁹ confirmed this belief. Modification of occlusal anatomy altered a measurable functional parameter. During closure of the mandible, the peak of elevator muscle electromyographic activity would occur closer to the intercuspal position following equilibration. The computer based analysis system provided an objective assessment of a clinical therapy. Occlusal anatomy, not classification of occlusion, influenced mandibular function.^{4,8,14,19}

Other studies have also utilized computers to analyze jaw function. Normal subjects, as well as patients before and after receiving various clinical therapies including selective grinding, full mouth

reconstruction, orthognathic surgery and orthodontic therapy, have been used to provide a data bank of correlates one might expect during normal and abnormal function.^{19,20,21,23,25} It should be noted however, that studies concerned with the development of masticatory function have been limited.²⁶ Perhaps future studies should examine the changes that may occur as the dentition develops through the deciduous, mixed and permanent stages.

Since Ahlgren's⁷ study, functional movements of the jaws have been recorded by electromagnetic techniques^{11,17,18,19,27} linear displacement transducers,^{13,28} light emitting and detecting techniques,^{29,30} and recently, radionuclide tracking.³¹ These methods for the continuous recording of jaw position all require some interference with the experimental subject.¹⁵ Constraints of the laboratory environment seem unavoidable. Hiiamae¹⁵ suggested that these constraints should "be realized and kept to a minimum consistent with standardizing recording conditions, analysis and measurement".

Computer based analysis of simultaneous jaw movement and muscle activity during function provides a useful technique for studying the human masticatory system and the effects of clinical alterations on the system.¹¹ Though this investigative instrumentation can provide simplicity of operation, lack of patient restriction, patient safety and the ability to record, sample and reduce data of several parameters simultaneously, there is still a need to develop standard measurement criteria and to further utilize computer technology to study human oral behavior.^{1,32}

Continued utilization of computer-based systems is important. These systems can help to provide a meaningful definition of what contributes to and constitutes normal masticatory function on the basis of physiologic criteria and not upon empirical grounds or anecdotal information.²⁵ In addition, computer-based analysis systems may provide an objective mechanism for comparing the efficiency (or its lack) of conventional and sometimes extravagant forms of restorative or occlusal therapy. If investigations of oral behavior can produce definitive statements about the functional changes one might expect in the normal child during growth, as well as changes occurring as a consequence of treatment or craniofacial abnormalities, we can begin to develop new criteria for clinical definitions of normality; measures which will also be useful in diagnosis.

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Influence of Oral Diagnosis Clerkship on Dental Graduates

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ABSTRACT

The Oral Diagnosis Department at the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore has offered for the past seven years an elective clerkship to students of high academic standing. In an effort to assess the influence of this experience on the career decisions of the participating dental students, a retrospective study of their professional development since graduation was performed. The results indicate that many of the students have continued their education, through graduate-training programs and/or teaching positions. Such post-graduate efforts occurred to a larger extent than those of their classmates. Reasons for these findings are discussed.

INTRODUCTION

Present dental school curricula represent, in general, formally structured courses of didactic and clinical instruction. While much evolution of the dental educational program has occurred over the past decade, one broadly-based student concern is that individualism and creativity are forced to give way to "bulks of educational material" being delivered to "masses of dental students." While there exist many logistical reasons for this situation, many dental educators are presently trying to improve dental curricula to accommodate the student's concern.

One such improvement has been to offer elective clerkships, in which selected interested dental students can focus concentration on specific interests. At the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore, all clinical departments and most basic science departments currently offer such programs for the senior dental students. Approximately 13% of the dental students last year participated in such efforts.¹

The Oral Diagnosis Department has offered a clerkship for the past seven years. Criteria for selection into this program include high academic standing with satisfactory clinical progress, as well as a strong interest in Oral Diagnosis/Oral Medicine. While the size of the clerkship has basically remained unchanged (approximately 2-3 students per year), the scope of the program has broadened as the students have developed their specific interests. At this time, the clerkship program offers training in oral medicine, anesthesiology, hospital dentistry, medical genetics, and principles of dental education. All students are initially required to participate in all facets of the program; additional concentration in any of these areas can then take place as interest dictates.

The oral medicine experiences are centered in the Oral Medicine Clinic, which is a referral-based clinic for the management of patients who have atypical or unusual oral conditions. Referrals come from the Dental School Clinics, as well as dental and medical clinicians in private practice. In the Oral Medicine Clinic patients have been diagnosed and/or treated for atypical facial pain, diabetes, temporomandibular joint myofascial pain dysfunction syndrome, oral neoplasms, ulcerative lesions, and other disorders. The clerkship students have been involved on levels of initial diagnosis as well as follow-up dental or medical therapy. Interesting or unique cases are presented by students in grand rounds format to the Oral Diagnosis faculty.

The anesthesiology experiences consist of a week's concentration in pre-operative evaluation and post-operative care, as well as in the actual administration of general anesthetic agents.

The students work directly with the dental and medical anesthesiologists, and by means of several different cases, learn firsthand the management principles of general anesthesia.

The hospital dentistry program dovetails the anesthesiology training. In this phase, students attend morning rounds with the medical team and follow-up on patients who are experiencing oral complications. In the past three years, this training has been centered at the Baltimore Cancer Research Program, a National Cancer Institute research program based in the University of Maryland Hospital. In this facility the dental students experience the unique opportunity to observe and participate in a joint medical-dental investigation into the multiple oral pathologies that affect patients, particularly those with acute leukemia.

The hospital at The Johns Hopkins University has been a part of the Oral Diagnosis clerkship since the beginning of the clerkship program. In this experience, weekly grand round discussions of patients with genetically-based abnormalities, many with oral manifestations, are presented. The students attend several of these conferences throughout the year, which reinforce their knowledge of the oral complications previously discussed in lecture in their undergraduate program.

Finally, since many of the clerkship students have expressed an interest in future teaching on either a part-time or full-time basis, the clerkship program has been expanded to permit the senior students to help supervise the sophomore dental students in Treatment Planning and The Emergency Clinics. Faculty continue to oversee both students, but student-student interaction additionally takes place.

MATERIALS AND METHODS

In an effort to determine the influence these experiences have on the dental clerkship students upon graduation, a retrospective survey of all students enrolled in the clerkship program was conducted in the fall of 1980. Through use of past dental student records, the offices of Academic Affairs and Student Affairs at the Dental School, and by direct telephone contact with the former clerks, the following areas of study were addressed:

- 1) Why did you elect to participate in the Oral Medicine clerkship program while you were a senior dental student?
- 2) What honors did you receive while you were an undergraduate dental student?

- 3) Have you formally continued your dental education since your graduation?
- 4) Have you involved yourself in either a part-time or full-time teaching capacity since your graduation? What is your current professional status?

RESULTS

The answers to these questions were as follows:

- 1) Why did you elect to participate in the Oral Medicine clerkship program while you were a senior dental student?

Ninety percent of the dentists (former students) interviewed said they had felt a need for more oral medicine and physical diagnosis training while they were dental students. It is important to note that, while these two areas have been receiving more emphasis for all dental students in the last three years, the most recent graduates expressed this need. Their interest within these disciplines ranged from specific areas, such as biopsy techniques and histologic examination, to a general "medical rounding out" of their undergraduate training. Thus, it appears that the clerkship students felt a strong desire for additional concentration in oral medicine and physical diagnosis disciplines.

- 2) What honors did you receive while you were an undergraduate dental student?

Since permission to participate in the Oral Diagnosis Clerkship program is restricted to students of high academic standing, it is not surprising that several of the dentists received academic honors while an undergraduate dental student. Eight of the students (38%) were elected into Gorgas, an honorary dental society into which sophomore students of high academic standing are elected. Twelve of the clerkship students (57%) were also elected into Omicron Kappa Upsilon upon graduation, in recognition of their strong academic and clinical skills. Finally, one student was president of the Student Dental Association while a clerkship student, a post to which he was elected by the senior class.

- 3) Have you formally continued your dental education since your graduation?

Four of the graduate dentists entered dental graduate programs (one each in periodontics, orthodontics, endodontics and oral surgery) upon their graduation from dental school. One

has completed a Master's program in education. The Dental School has in past years collected data on the graduating classes, and comparison of the clerkship students' interests to those of their classmates revealed several findings.^{2,3} For example, the percentage of 1978 and 1979 clerkship students entering such programs was 17%, compared to 8% for the rest of the student body. In addition, 67% of the clerkship students in these years entered general practice residencies, compared to 49% of the remaining students.

- 4) Have you involved yourself in either a part-time or full-time teaching capacity since your graduation? What is your current professional status? Since teaching was often an interest to the clerkship students, this area was researched. It was determined that 11 (52%) are in full-time private practice, 4 (19%) teach part-time in a dental school, and 1 (5%) teaches full-time. Two of the part-time teachers are presently in graduate programs. Compared to 2% of the 1978-79 graduates, 33% of the clerks from those two years are presently in either full or part-time teaching capacities in dental school settings.

DISCUSSION

Upon evaluation of these responses, several findings become evident. The Oral Diagnosis clerkship students in general were a highly-motivated, intellectually stimulated group of dental students. The original selection process for their entry into the program accounts to a large degree for this finding. These traits continue to be evident by their interests in either graduate and/or teaching level positions in dentistry upon their graduation. Their participation in these fields was much greater than the dental student body generally.

The Oral Diagnosis clerkship program appears to meet the needs and expectations of the clerkship student. The training they receive complements their natural interests; this focus allows them to sharpen their career plans. Several have become directly involved in dental education; this is not surprising since careers in Oral Diagnosis are primarily centered in an academic setting. It appears that the teaching experience the dentists received while they were clerkship students encouraged several of them to further pursue this aspect of their career.

The Oral Diagnosis clerkship program is a continually evolving, always expanding dimension

in dental education. Based upon the record of student accomplishment described in this paper, the program appears to be more than accomplishing its goal of tailoring a dental school experience to the students' academic and clinical interests.

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CASE STUDY

BILATERALLY SYMMETRICAL IMPACTED SECOND AND THIRD MANDIBULAR MOLARS- A TEN YEAR FOLLOW-UP

Christopher B. Hoek, D.D.S.
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A ten year old black female was seen at the University of Maryland Dental School, for comprehensive care. On the panorex, (figure 1) the second and third maxillary and mandibular molars were noted to be unerupted, which was consistent with a normal chronological eruption pattern. A left mandibular posterior supernumerary tooth was also noted to be developing. Only routine operative care was felt to be warranted at this time, with the unerupted teeth to be followed radiographically at routine check-ups.

Ten years later the patient returned to the Dental School with a complaint of pain in the mandibular posterior regions. Radiographic examination (figure 2) revealed bilaterally symmetrical impacted second and third mandibular molars. An impacted left mandibular supernumerary bicuspid was also present. All five teeth were subsequently removed surgically without complication.

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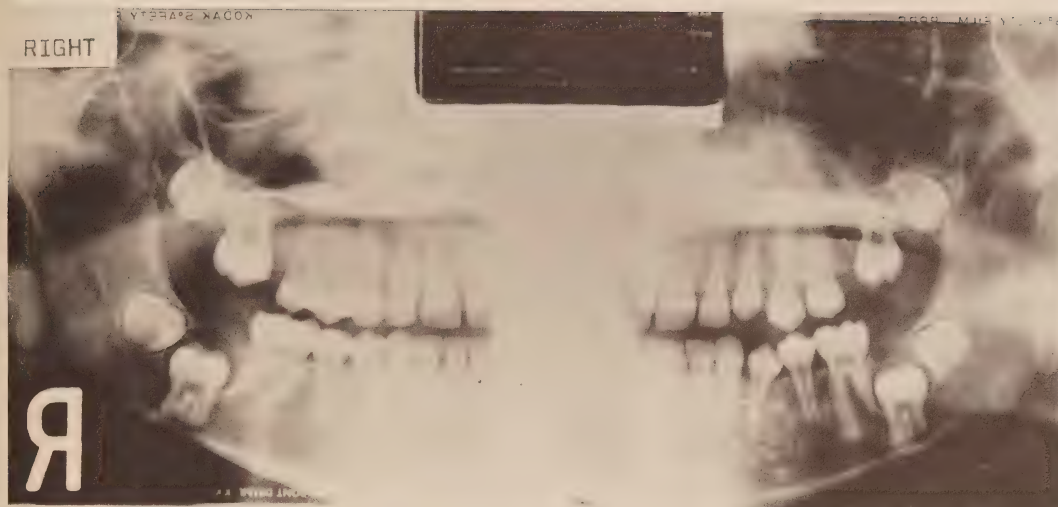


Figure 1: Initial Panorex, Age 10



Figure 2: Panorex (10 years later) showing symmetry of impacted second and third mandibular molars

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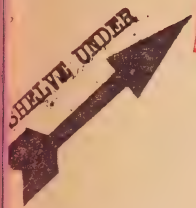
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DOROTHY S. LINTHICUM, M.A.
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The Concurrent Patient Care Program: An Introduction to the Cotherapist Approach to Dental Care

Susan S. Miller, R.D.H., M.S.
Louis G. DePaola, D.D.S.

ABSTRACT

Almost half of the private dental practitioners in Maryland employ one or more dental hygienists. A Concurrent Patient Care Program has been incorporated into the curriculum of the Baltimore College of Dental Surgery to provide dental and dental hygiene students with the opportunity to experience the "team approach" as cotherapists in the delivery of dental care. The program fosters both the development of effective professional communication and the behaviors and interactions necessary to meet the demands of post-graduation private practice.

INTRODUCTION

Many dental educational programs include in their curricula rotation or extramural assignments during which dental students work with traditional or expanded function dental assistants. Fewer institutions have developed programs for dental and dental hygiene students to work together in delivering comprehensive care. The number of dentists employing hygienists is increasing. Nationally, 41 percent of private practitioners employ one or more hygienists on either a full or part-time basis.¹ In the State of Maryland, the employment figure approaches 43 percent.² Since so many people contribute their special skills toward the care of the patient, each professional must depend on the satisfactory performance of fellow team members. Dental professionals have become interdependent; they must rely on others' contributions to accomplish their goal of providing quality dental care. They must also be able to coordinate their work in ways that maximize the use of their technical skills and that promote patient and individual satisfaction.³ An educational experience which focuses on the "team approach" to the delivery of dental care can potentiate each students' appreciation for the interdependent roles they have in providing patient care.

At the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore, dental and dental hygiene students have planned opportunities to work together to provide comprehensive care to dental patients. The Concurrent Patient Care Program is designed to provide both groups of students with supervised experiences in rendering patient care cooperatively in a manner which closely simulates the post-graduation practice of dentistry and dental hygiene. In a cotherapist relationship two professionals render the components of comprehensive patient care for which they are educationally prepared and legally licensed. In the medical profession the cotherapist relationship between nurse and physician is well established and is introduced, developed, and rehearsed from the inception of both professional curriculums.

THE CONCURRENT CARE PATIENT PROGRAM

The program extends over a period of one and a half academic years allowing students to mature as a team and experience the cotherapist approach to dental care. The program has two phases, the first of which begins with the concurrent assignment of a patient to third year dental-dental hygiene student teams. It is in this first phase that the concept of cotherapy, as it relates to private practice, is introduced and developed. Students in each group are aware of their different levels of didactic and clinical experiences, particularly in the

collection of comprehensive base line data, and must work together to develop an approach to care that addresses the patients' needs, and each clinician's goals for that time. Dental hygiene students need to identify the components of data collection they feel competent to provide while dental students must identify those components they feel comfortable with delegating. Preventive services are by design always the responsibility of the dental hygiene student.

Phase two of the program directly evolves from this beginning professional interaction and incorporates new levels of didactic preparation and clinical experiences. In this phase the dental hygiene student assumes total responsibility for all components of data collection and continues to provide the preventive services. While all student teams should adopt the second phase protocol by the beginning of their fourth year, many students are performing at this level much sooner.

Each dental hygiene student typically works with four or five different dental student partners. These multiple assignments result in clinical opportunities to render treatment to a variety of patients with a range of treatment needs. This design also enables the hygiene student to appreciate the unique approach of individual dental practitioners and the acceptable variances in treatment modalities. In both phases of the program the dental student reviews the data, makes treatment decisions, and manages the patient's total care, as should a practicing dentist. Students begin working together as soon as a patient is designated for concurrent care. They review the patient record, decide on a mutually convenient schedule for data collection, review clinical findings, evaluate their patient's need for palliative or emergency treatment, and keep one another informed on the patient's and their progress. A comprehensive treatment plan is developed for each patient by the dental student and is presented to and approved by dental faculty. Dental hygiene students are encouraged to be in attendance when treatment plans are presented so they might become familiar with the full scope of the patient's treatment. Student teams are encouraged to continue the cotherapist relationship throughout all phases of the patient's treatment by reviewing the results of the therapies provided by either student.

Prior to the initiation of this program at the Baltimore College of Dental Surgery dental and dental hygiene students had no designed opportunity to work together in providing care to pa-

tients. The introduction of the Concurrent Patient Care Program has filled this void and helped to increase each student's appreciation for their roles in providing comprehensive care to a variety of patients with a range of needs.

DISCUSSION

The planning of patient care programs involving two different groups of students can present many problems. Scheduling has been, and continues to be, the primary difficulty in the Concurrent Patient Care Program and has at times resulted in extended total treatment time. The benefits to be derived from the cotherapist experience, however, far outweigh the minor delays encountered. Dental students are encouraged to designate someone from their current patient load for concurrent therapy because appropriate patient selection and assignment are also at times a problem. When this is not possible, the Office of Clinical Affairs designates a patient for the team whose needs complements each students' set of experiences. Should student teams experience interpersonal or management problems, they are encouraged to resolve them independently since one of the goals of the program is to encourage students to build effective professional communication and behaviors.

The major strength of the program is the interaction between two primary oral health care providers. The dental student has the opportunity to manage and review the rendering of the dental hygiene care while the hygiene student has the opportunity to consult with a specific dental student in developing treatment for a patient, as would happen in a private practice setting. Both students have the chance to develop sets of practice behaviors that can be built upon as they begin their professional careers. The dental hygiene student has the opportunity to comprehensively assess the patient's oral health care status and plan and provide comprehensive preventive services designed to meet the individual needs of her patient while the dental student can practice the management of, and assume responsibility for, the total care of a patient.

CONCLUSION

The cotherapist approach to dental care promotes an efficient, effective and unified practice design. The concurrent patient care program implemented at the Baltimore College of Dental Surgery encourages dental and dental hygiene students to define their appropriate professional roles

and to assume responsibility for rendering the aspects of patient care for which they have been educated.

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Muscle Rigidity and Respiratory Arrest with Alphaprodine: A Case Report

Louis G. DePaola, D.D.S., M.S.

Mark Z. Eisen, D.D.S.

ABSTRACT

Muscle rigidity and respiratory depression are potential adverse effects of narcotic analgesics when given parenterally. The administration of the narcotic analgesic alphaprodine has been known to produce severe respiratory depression and even death. However, to our knowledge, this is the first known reported incidence of muscle rigidity with this agent in dentistry.

INTRODUCTION

Alphaprodine (Nisentil*) is a potent synthetic narcotic analgesic that closely resembles meperidine in potency and pharmacologic action. The usual adult dose of 0.4-0.6 mg/kg intravenously or 0.4-1.2 mg/kg subcutaneously produces an onset of action in one to two minutes and five to ten minutes respectively (Roche Laboratories, 1967). Intravenous administration of alphaprodine provides 45 to 90 minutes of analgesia while the duration of action by the subcutaneous route is about forty-five minutes (Gruber, Lee and Gruber, 1950). The rapid onset and short duration of action make alphaprodine an excellent drug for outpatient dental anesthesia (Burbank, 1963). Adverse effects of alphaprodine are respiratory depression, nausea, apnea and hypotension (Gottschalk, Orkin and Rovenstine, 1955). Respiratory depression can be severe and if not recognized and corrective action taken, serious sequelae and death can occur (Hine and Pasi, 1972).

A major adverse reaction of the narcotic class of drugs is muscle rigidity involving the musculature of the chest, abdomen, neck and jaws (Sokoll, Hoyt and Gergis, 1972). Hamilton and Cullen (1953) first reported this phenomenon with compounds containing fentanyl. Sokoll et al (1972) reported that all narcotics produced an increase in abdominal tone and this increased dramatically with the concomitant administration of nitrous oxide. There are no previous reports of muscle rigidity associated with respiratory depression after administration of alphaprodine in the literature.

CASE REPORT

A well developed, well nourished 27 Kg 41 year old black female presented to the Oral Surgery Clinic of the University of Maryland School of Dentistry on October 12, 1979 for consultation concerning dental extractions and alveoplasty to be performed as an outpatient using an intravenous sedation, local anesthesia and nitrous oxide: oxygen technique. The past medical history was negative for rheumatic fever, heart murmur, cardiovascular, respiratory, renal, endocrine and hepatic diseases. The patient was allergic to penicillin, and claimed that codeine and propoxyphene caused her to feel "spaced out." Because of past episodes of anemia, she took ferrous sulfate daily. The remaining history was non-contributory. The patient was given instructions and scheduled for surgery.

On November 7, 1979 the patient returned to the clinic. She had been NPO for the past eight hours and was accompanied by a responsible adult. Preoperative vital signs were as follows: blood pressure 100/75, pulse 78, respirations unlabored. With the patient in a semi-reclining position a 21 gauge butterfly was inserted into a vein in the dorsum of the left hand and a 5%

dextrose intravenous infusion started. Diazepam to a total of 15 mg and alphaprodine to a total of 18 mg was titrated intravenously over a period of five minutes. In addition, a 50:50 mixture of $N_2O:O_2$ was given through a nasal inhaler with McKesson pop-off valve. Local anesthesia, 2% lidocaine with 1:100,000 epinephrine, was administered. The stimulation of the injection aroused the patient so another 6 mg increment of alphaprodine was administered. Over the next 2 minutes, the patient became lethargic, and eventually non-responsive. The mandibular and chest muscles became rigid. There was no movement of a clonic or tonic nature. It was impossible to force the patients mouth open to insert a mouth prop. Respirations became shallow, then ceased entirely. The N_2O was immediately shut off and 100% O_2 was given. It was difficult to ventilate the patient with positive pressure, via the McKesson valve. Naloxone hydrochloride 0.4 mg was administered intravenously and the airway was maintained with positioning. The blood pressure and pulse remained stable. After approximately thirty seconds the patient responded to the naloxone hydrochloride. Respirations increased in rate and depth and the patient was once again able to respond to command. The surgical procedure was completed without difficulty using local anesthesia, diazepam, and $N_2O:O_2$. Vital signs at the termination of the procedure were blood pressure 110/70, pulse 76, respirations unlabored. The patient was monitored in the recovery room for one hour then discharged with her escort. No further adverse effects from the anesthesia were experienced, and the patient had no recollection of the episode.

DISCUSSION

The sudden onset of muscular rigidity after the final incremental administration of alphaprodine is suggestive of muscle rigidity reported with other narcotic agents. Grell, Koons and Denson (1970) reported that with fentanyl, muscle rigidity did not appear until a dosage of 0.25 mg was exceeded, after which some degree of muscle rigidity was almost always detected. The study further showed that too rapid a rate of infusion of fentanyl lead to an increased incidence of muscle rigidity, recommending a continuous slow IV infusion technique to reduce this phenomenon. A case of respiratory arrest with alphaprodine 60 mg and diazepam 2 mg was reported by Anderson and Steege (1975) with successful resuscitation and Fleckenstein and Lifshay (1979) found severe respiratory depression and apnea with intravenous

alphaprodine and diazepam in 1.4% of healthy patients undergoing gynecological procedures during an 11 month period. Rosenberg (1977) stated that naloxone hydrochloride 0.2-0.4 mg, a narcotic antagonist, was successful in reversing the respiratory depression and chest wall rigidity in a case involving the use of fentanyl.

There are no know reports of muscular rigidity following the administration of alphaprodine, however, alphaprodine is chemically related to fentanyl and meperidine which are known to produce muscle rigidity. Therefore, it is likely that alphaprodine should also be capable of causing a rigidity of the respiratory muscles with a reduction in chest wall compliance and a resultant decrease in lung expansion. The case reported is strongly suggestive of this phenomenon because of: 1) rapid onset of action after administration of the final incremental dose; 2) clinical presentation; 3) the reported increase in abdominal muscle tone with the concomitant administration of nitrous oxide and narcotic analgesia and; 4) the reversal of clinical symptoms after administration of the narcotic antagonist. The exact mechanism of muscle rigidity is currently unknown although it probably involves an area of the CNS (Sokol et al, 1972). This report supports the concept that narcotics as a class are capable of producing a wide range of side effects including respiratory depression associated with muscle rigidity. Practitioners who utilize these agents must acquaint themselves with the clinical signs and symptoms of muscle rigidity and respiratory depression. The rapid onset of adverse side effects with possible serious sequella in the authors' view limits the use of alphaprodine and similar narcotic analgesics to those experienced in the use of anesthetic agents and life support equipment.

CONCLUSION

A case of respiratory arrest and muscle rigidity following administration of alphaprodine is reported. Practitioners who employ narcotic agents as part of a pain and anxiety control regimen, should be aware of all potential adverse reactions associated with these agents. It is essential that these practitioners be capable of recognizing the presence of these reactions and take appropriate corrective steps.

AUTHORS NOTE

Alphaprodine (Nisentil*) has subsequently been recalled by Roche Laboratory due to its

respiratory depression and other associated adverse effects.

*Roche Laboratories, Nutley, New Jersey.

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Students' Responses To The Dental School Orientation Process

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ABSTRACT

Orientation programs for students entering professional schools have been carried out in a traditional manner emphasizing the academic and administrative aspects of adjustment. Neither the format of these programs, nor their impact on student's attitudes toward the dental curriculum have been discussed in the literature.

The purpose of this study was to evaluate the orientation program designed for freshmen dental students of the 1979-1980 academic year at the Baltimore College of Dental Surgery, Dental School, University of Maryland.

Review and evaluation of past orientation programs at the University of Maryland suggested there might be value in inviting family, spouses, and friends of the incoming freshmen to participate in the program. In addition, it was felt that demonstrations on aspects of the first year academic program would be valuable in acquainting freshmen dental students and their guests with the various aspects of the dental curriculum.

Questionnaires, designed to measure student's attitudes toward the orientation program, were administered four weeks after the beginning of the first semester. Results demonstrated the usefulness of this type of Orientation Program.

INTRODUCTION

Orientation programs are used in professional schools to acquaint students with the philosophy and goals of the curriculum and to help them to sense their position in relation to their new environment.^{1,2,3}

Dental training is unique in professional education in the excessive demands on student time needed to fulfill didactic and laboratory requirements. Several studies,^{1,4} have documented that the majority of dental students experience stress in varying intensities, particularly during the freshmen year. Many experts suggest that students in stressful situations exhibit psychological and physical symptoms including depression and drug abuse.^{5, 6} In addition, a dental education may adversely effect the values of students. Often this occurs in conjunction with an increase in cynicism after graduation from dental school.^{7, 8}

Some schools have made an effort to counter the confusion and anxiety of freshmen students by providing a big brother/sister program. In these programs each freshman is assigned a sophomore big brother or sister who is expected to provide additional support to the freshman by acting as a guide and advisor.

Feeling that this system alone was not sufficient, a University of Maryland dental student⁷ piloted a new type of orientation program. By inviting family and friends of incoming freshmen, for a full day of small group discussions, the student hoped to educate and sensitize them to the dental experience that lay ahead. As a result of the success of this program, the University of Maryland Dental School established an Orientation Committee. The committee was composed of faculty and students who were members of the school's Student Affairs Committee and the Big Brother/Big Sister Committee. The committee's charge was to conduct and evaluate the orientation effort in a more comprehensive way.

Orientation programs at the University of Maryland are designed to accomplish three main objectives:

1. To provide traditional orientation toward school policy, and accomplish registration and equipment distribution.
2. To allow familiarization of the freshmen with school surroundings and with their big brother or sister.
3. To encourage participation and education of family and friends in order to orient them to the demands of professional school.

The orientation program was conducted over a three day period. On the first day all incoming freshmen students and their guests were greeted and welcomed by the Dean. Next, many small group tours of the Dental School were conducted by

volunteer student guides. During the tour, the guests were exposed to physical settings including classrooms, clinical modules, and basic dental sciences laboratories.

In the afternoon, while students were registering for fall classes, guests were involved in small group discussions. The moderators of each group included a full time faculty member, a married student, and an unmarried student. The discussions provided the guests with knowledge about course work, laboratory requirements, and examinations. The moderators pointed out the degree to which emotional and mental stresses were prevalent among dental students and revealed circumstances that might provoke anxiety and stress. In addition, the signs and symptoms of these psychological entities were explained. The moderators emphasized that families, spouses, and friends were the ones who would be most able to help the student handle his problem in a realistic way.

Following this small group session, students and their guests were invited to observe the varied activities comprising the first year academic program. Student volunteers were distributed through-

out the pre-clinical laboratories performing and explaining various aspects of the first year program. Demonstrations included: general restorative, crown and bridge, occlusion, waxing, anatomical dissection, microbiology, and physiology. Audio-visual materials were heavily utilized as well as handpieces and other dental equipment. Guests and students were encouraged to participate in "hands on" experiences.

After the demonstrations, the incoming freshmen attended a student panel session. The moderators, who were members of the Student Dental Association, discussed various aspects of student life at the school. Freshmen also had an opportunity to receive and discuss information about educational requirements. During that time, guests were treated to refreshments and shown a film about the city of Baltimore. Guest participation ended with the close of the first day of orientation. (For details of the final two days of orientation Table 1.)

METHOD OF EVALUATION

Four weeks after the beginning of the fall semester, questionnaires were administered to the

TABLE 1
Orientation Program Schedule
August, 1981

| <i>Date</i> | <i>Time</i> | <i>Activity</i> |
|-------------------------------|-----------------------|--|
| Wednesday, August 22, 1979 | 8:30-9:30 a.m. | Campus Orientation |
| | 9:30-11:30 a.m. | Tour for Students and Guests |
| | 11:30 a.m.-12:30 p.m. | Lunch |
| | 12:30-2:30 p.m. | Registration and Photo I.D. (Students only) |
| | 12:30-1:00 p.m. | Guests get together |
| | 1:00-2:30 p.m. | Small group discussion for guests |
| | 2:30-3:30 p.m. | Demonstration of first year academic program |
| | 3:30-4:30 p.m. | Aspects of Dental Student life |
| | 3:30-4:30 p.m. | Guests get together |
| Thursday, August 23, 1979 | 8:00-9:00 a.m. | Check in, Name tags, Composite Pictures, Mail Box keys, BDS keys and Lab coats |
| | 9:00 a.m.-12:00 Noon | Anatomy Lab Manuals and Bone Boxes |
| | 12:00 Noon-1:00 p.m. | Lunch |
| | 1:00-2:00 p.m. | Codesco, Pay for instruments |
| | 2:00-3:10 p.m. | Professional Orientation |
| | 3:10-3:30 p.m. | Campus Security |
| Friday, August 24, 1979 | 3:30-5:00 p.m. | Student Reception Sponsored by the Alumni Association |
| | 8:30-9:30 a.m. | Test in Mechanical Insight (Pre-test) |
| | 9:30 a.m.-1:00 p.m. | Equipment Distribution |
| | 1:00 p.m. | Big Brother/Big Sister Picnic |

freshmen class. The purpose of the questionnaires was to measure student attitudes toward the orientation program. Insights developed from the responses to this questionnaire were to be used in the improvement of the following year's orientation program.

The questionnaire (TABLE 2), comprised of twenty-one questions, was designed to explore the following three major areas:

1. The effectiveness of the orientation in preparing freshmen for life in Baltimore, classes, and labs; and other matters related to equipment and registration requirements. (Question numbers 1, 2, 3, 4, 5, 6, 10, 14, 16, 17, and 18)
2. The students' attitudes toward inviting families, spouses, and friends to the program. (Question numbers 7, 11, 13, and 15)

3. The effectiveness of the different panel discussions in increasing student knowledge of and understanding about the school's academic and social life. (Question numbers 8, 9, and 12)

Out of 125 freshmen students attending orientation, 93 responded.

RESULTS

The greatest number of questions dealt with the effectiveness of the orientation program in preparing the dental student for all aspects of life during their matriculation. Seventy-three percent of the students responding to the questionnaire expressed positive attitudes toward this focus of the orientation program; fourteen percent expressed negative attitudes; and, thirteen percent, no opinion. (TABLE 3). Although most students

TABLE 2
Questionnaire

KEY
A. No Opinion B. Strongly Agree C. Agree D. Disagree E. Strongly Disagree

1. The Big Brother/Sister committee was helpful in ordering Coats.
2. The Big Brother/Sister committee was helpful in ordering Lamps.
3. The Big Brother/Sister committee was helpful in ordering Name tags.
4. The housing and apartment list sent in June was helpful in securing housing.
5. The tour at the Dental School was well organized.
6. The tour at the Dental School was worthwhile.
7. The tour guides descriptions were informative and clear.
8. Time allocated for registration was adequate.
9. Instructions concerning the process of registration and I.D. Photos were clear and helpful.
10. Inviting families to the orientation was a good idea.
11. The Student Panel about the aspects of student life worthwhile.
12. The Student Panel consumed more time than it should have.
13. The distribution of mail box keys and BDS Lab keys was well organized.
14. Only students should attend orientation.
15. The Student Dental Association representative covered most problems related to dental student life thoroughly and clearly.
16. The guests became acquainted with the curriculum and rigor of the Dental School.
17. The comments and remarks of the gentlemen who moderated the professional orientation were meaningful.
18. I was embarrassed to invite my parents and/or spouse to come to the orientation program.
19. I get along well with BB/BS.
20. My BB/BS was helpful in preparing me for classes and labs.
21. I got in touch with my BB/BS immediately after I received the assignment.

KEY
A. YES B. NO

22. Were you accepted to University of Maryland Dental School before AUG. 10, 1979?
23. What activities could be eliminated from the orientation program?
24. What activities could be added to the orientation program?
25. Have you ever visited a dental office other than as a patient or a salesman?

(79.5 percent) found their big brother or big sister helpful, many found it unnecessary to get in touch with him/her after receiving their name (40.8 percent). The largest negative response was registered to the question asking about whether the time allowed for registration was adequate (21.4 percent). This was corroborated by a large number of students' comments in the open-ended section of the questionnaire about long lines during registration. With the exception of one question, most students (~85 percent) expressed an opinion—either negative or positive—on all of the items. Sixty-four percent of those surveyed had no opinion about the helpfulness of the housing and apartment list. It would seem that the majority of students already had the housing situation settled before they received the list. Of those students who did express an opinion, though, more than two-thirds found the list helpful (28 percent to 9 percent).

A second topic explored in the questionnaire was the question of student attitudes toward the invitations made to family members and friends to attend orientation. This was done in an effort to acquaint them with the difficulties students will encounter as they adjust to dental school. Few students were negative about this aspect of orientation (8 percent) although a fairly large percentage (23 percent) expressed no opinion in this area. Sixty-nine percent had a positive attitude toward inclusion of family and friends in the orientation (TABLE 3). Although only two percent of the stu-

extension of the invitation.

Ten percent of the students were embarrassed to invite family and/or friends to the orientation, fifty-nine percent were not, while thirty-two percent expressed no opinion on this topic. This may be because only fifty percent of the students took advantage of the offer to include families in the orientation. In answer to the most important question, the majority of the students felt their guests became acquainted with the curriculum and rigor of the Dental School as a result of orientation; nine percent felt the opposite, while a large percentage had no feelings on this issue (32 percent).

The third area of investigation on the questionnaire also produced a large percentage of no opinion responses. When being asked about the effectiveness of the panel discussions, thirty-three percent of the students expressed no opinion, while fifty-six percent were positive and eleven percent, negative (TABLE 3). While the majority of students felt that the student panel was worthwhile (63 percent), and the S.D.A. representative was effective (58 percent) and only four percent felt the panel was not valuable, fifteen percent of the students felt the panel was too long. Forty-six percent were not bothered by the amount of time spent in listening to the panel discussion while thirty-eight percent had no opinion.

DISCUSSION

In all areas of the questionnaire, negative feelings about orientation were expressed by only a small percentage of the respondents. Students were most favorable about the effectiveness of the orientation in preparing them for the technical aspects of dental school life. They were almost as positive about the decision to include families and friends in the orientation program. They were least positive about the effectiveness of the panel discussion in preparing them for the academic and social life of the school. While the majority were positive, perhaps the large group of respondents expressing no opinion were surveyed too early in their dental school career to appreciate what they had absorbed during the panel discussions.

To further evaluate this type of orientation program in the future, it is suggested that guests should also be asked to complete questionnaires on topics pertinent to their program participation. Follow-up evaluations, possibly six months or a year after orientation, would also provide insight into the success of this concept.

TABLE 3
Attitudes of Students Toward
Major Orientation Program Emphases

| | <i>Positive</i> | <i>Negative</i> | <i>No Opinion</i> |
|--|-----------------|-----------------|-------------------|
| Technical and Administrative Aspects | 73% | 14% | 13% |
| Inclusion of Families in Programs | 69% | 8% | 23% |
| Effectiveness of Panel Discussions | 56% | 11% | 33% |

dents strongly disagreed with the idea of inviting family and friends to orientation, ten percent felt that only students should attend. For both these concepts, less than fifteen percent of the students had no opinion while the others were positive about the

CONCLUSIONS

This paper reported an attempt by the Dental School of the University of Maryland to reduce the stress associated with attending dental school through a unique concept in orientation format. Unfortunately, programs that address the adjustment problems of freshmen dental students in a prophylactic way are scarce. The authors believe that including family and friends in small group discussions during the orientation program serves in accomplishing student adjustment in a less stressful manner.

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Costs of Accreditation Process to the Dental School

Dorothy S. Linthicum, M.A., and Ernest F. Moreland, Ed.D.

ABSTRACT

Over the years, the process of accreditation has been studied from almost every angle. The benefits have been weighed, the purposes redefined, and the weaknesses debated.

However, one element—the cost—has received only scant attention. The Cost Assessment Program (CAP) was established to evaluate costs associated with accreditation.

Total direct costs of the Dental School accreditation process, from the initial planning phase of the self-study in August 1979 through the site visit in January, 1981, were over \$200,000. These costs primarily represent time spent by faculty and staff, which totaled about 12,200 hours.

Student attitudes on the whole were positive. The two most positive ratings were in faculty accessibility and quality of instruction, where students indicated accreditation activities had not interfered with the learning process.

Overall, attitudes of faculty toward the effect of the self-study on faculty accessibility, quality of instruction, research and service were positive. The majority indicated that research had been the area of responsibility most affected by the self-study.

Knowledge of the costs of accreditation can lead to a better understanding of the process and the limits of its benefits. Because it is difficult to quantify all the benefits of accreditation, there is no way to ascertain if the \$200,000 cost was justified. The only certainty is that the costs are real, and should no longer be ignored by either the ADA Commission on Accreditation or dental schools facing site visits.

INTRODUCTION

Over the years, accreditation has been studied from almost every angle. The benefits have been weighed, the purposes redefined, and the weaknesses debated. However, one element—the cost, both direct and indirect—has received only scant attention.

Despite the long history of accreditation, few have tried to measure the qualitative and quantitative costs of preparing for a site visit. Resources are often diverted from the teaching, service and research responsibilities of an institution. When money was readily available, these costs were easily absorbed. However, as inflation and reductions of public funds have put a strain on budgets, the requirements and number of accrediting agencies have proliferated. Nowhere is this more true than in the dental professions. In addition to separate approval of postgraduate programs, a new layer, the self-study, has been added to the accreditation process.

The necessity or benefit of accreditation is not in question. To determine better the future role of accreditation, however, benefits should be weighed against some estimate of the costs.

METHODOLOGY

A Cost Assessment Program (CAP) was established to study costs associated with the January 1981 ADA Commission on Dental Accreditation site visit at the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore. CAP was funded by the Dental School and the American Fund for Dental Health. The study measured not only direct costs of time and other expenditures, but also indirect costs of diverted resources and changes in morale and attitudes.

The major direct cost to the Dental School came from time spent by faculty and staff on accreditation activities. To define this time, monthly logs were distributed to all faculty and secretarial staff for the recording of time spent on individual accreditation tasks. The logs were divided into categories corresponding to sections of the *Self-Study Manual*. The secretarial log also included a form to record duplication related to accreditation activities. Time spent in committee meetings was determined from a review of minutes, which included attendance rosters. Throughout the self-study and the time preceding the site visit, mechanisms were used to increase the response rate. Random interviews also were conducted with non-respondents to assess their level of activity in accreditation.

Indirect costs were defined as the non-monetary aspects of accreditation that may have affected the operation of the Dental School. Three survey instruments were designed to measure attitudes of students, faculty, and secretaries toward accreditation. In addition, continuing education activities, research proposals and funding, and regular faculty meetings were monitored to detect shifts in priorities.

In addition, an analysis was made of the self-study methodology employed by the Dental School. This included monitoring data collection efforts and the effectiveness of the committee structure and analyzing the usefulness of the Commission's *Self-Study Manual*.

Every effort was made to limit the intrusion of the CAP project during the course of the self-study. Results were not released until the conclusion of the study, and none of the survey groups were biased by data from another group.

RESULTS

The results section included analysis of both the direct and indirect costs of accreditation to the Dental School.

DIRECT COSTS

The total direct costs of the Dental School accreditation process, from the initial planning phase of the self-study in August 1979 to the site visit in January 1981, were about \$200,000 (see Figure 1). These costs primarily represent time spent by faculty and staff, totaling about 12,200 hours. (Estimates of time spent by nonrespondents boost direct costs to about \$230,000.) Other costs include expenses of two faculty retreats, duplication and paper, postage, telephone and similar expenditures.

During the 18-month process, the average administrators (deans and their associate staffs)

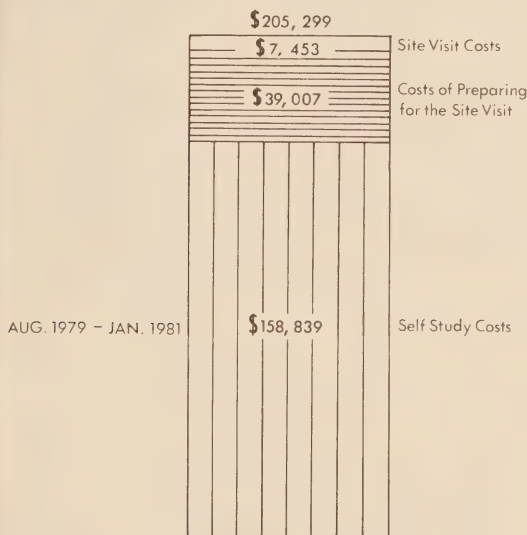


Figure 1. Total direct costs of the Dental School accreditation process.

spent an average of 200 hours on accreditation-related activities. Department chairmen spent an average of 133 hours, and nonadministrative faculty spent an average of 44 hours, with a range of less than an hour to over 200 hours. The average secretary spent about 86 hours.

SELF-STUDY (AUGUST 1979-JULY 1980)

The total direct costs of completing the accreditation self-study were almost \$160,000 (see Figure 2). If costs of individual time were projected to include nonrespondents, total costs would come closer to \$180,000. The major cost came from time spent by faculty and staff individually, over 70 percent of the total.

Costs of the DDS portion of the self-study were about \$135,000, about 85 percent of the total spent. The Dental Hygiene study came to more than \$10,800, 7 percent of the total, while the Advanced Specialty Education study cost \$13,500, 8 percent of the total (see Figure 3).

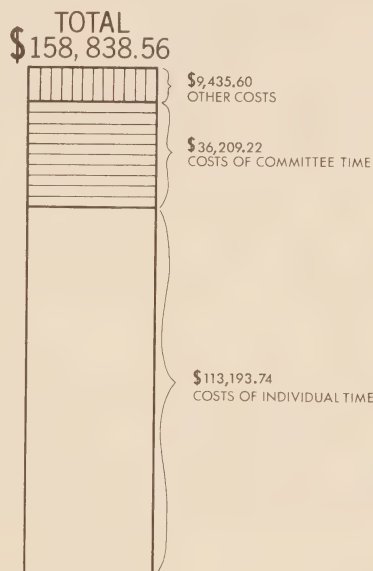


Figure 2. Direct costs of the Dental School self-study.

Monthly comparisons of time spent indicate levels of activity during the self-study (see Figure 4). The busiest months came in January and February when reports were being compiled. Although some faculty felt that the four months the Dental School allotted for collecting data and compiling reports was too limited, there is some indication that the work would have been done in the final

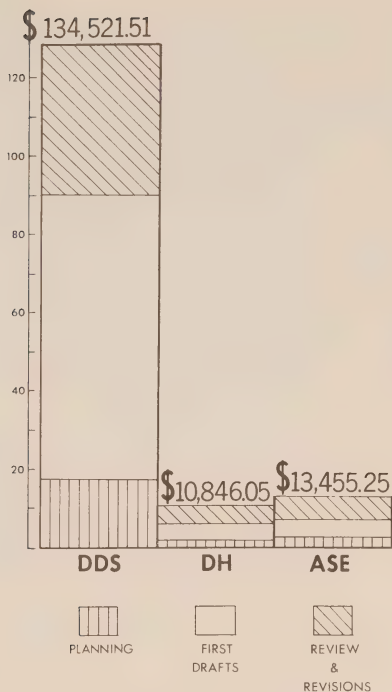


Figure 3. Direct costs of the DDS, DH and ASE self-studies.

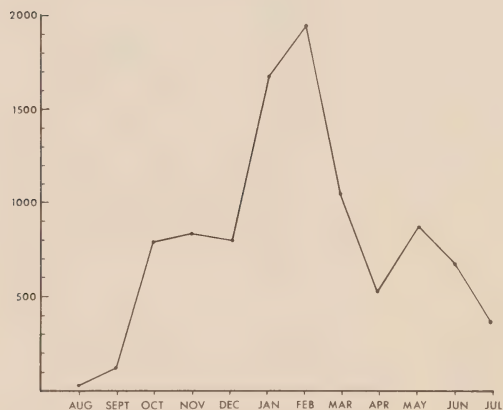


Figure 4. Time spent each month on the Dental School self-study.

weeks no matter how long the time allotment. The busiest month during the review and revision process came in May. By this time, special Review Subcommittees had examined all reports and returned them for revisions. Much of the time spent at this juncture is attributed to department

chairmen and secretarial staff who revised content or corrected format errors. Time spent each month ranged from 30 hours in August to almost 2,000 hours in February. Total hours spent ranged from 9,900 actual hours reported by faculty and staff to about 11,500 projected hours.

Comparisons were also made of the average time spent each month by type of personnel (see Figure 5). Administrative faculty, including depart-

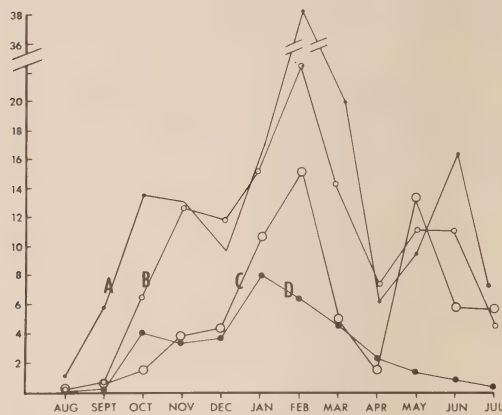


Figure 5. Average time spent by (A) department chairmen, (B) administrators, (C) nonadministrative faculty and (D) secretaries of the Dental School self-study.

ment chairmen, usually logged the most time each month. During February, the average administrator was unavailable for routine activities 3 to 5 work days out of 21. Full-time nonadministrative faculty were most involved in January, spending an average of 8 hours on accreditation. These figures are somewhat low because of those faculty who spent little or no time on accreditation activities. Time spent each month ranged from 0 to 50 hours for individual faculty members. Because substantial changes were required in the format of many reports, secretaries spent almost as much time in May as in February.

PREPARING FOR THE SITE VISIT (AUGUST 1980-JANUARY 1981)

The direct costs of preparing for the site visit from August 1980 to January 1981 were about \$39,000. About 80 percent of these costs can be attributed to time spent by faculty and staff at the October retreat, preparing exhibits, collecting information, and compiling self-study progress reports.

During this time period faculty and staff logged about 1,900 hours. About half of these hours were spent in meetings, such as the retreat. The average administrator spent about 32 hours during this period, while department chairmen spent about 15 hours. Nonadministrative faculty spent an average of about 7 hours, and secretaries spent an average of 12½ hours.

SITE VISIT (JANUARY 12-16, 1981)

Direct costs incurred by the Dental School during the week of the accreditation site visit were about \$7,450. (Costs to the Commission on Accreditation for travel and accommodations and indirect costs to members of the site visit team and their respective institutions are not included.)

The total hours spent during the site visit came to about 370. Almost 60 percent of this time was accounted for by faculty meetings with team members. Individual time was spent reviewing the self-study, collecting additional information, and cleaning up work areas. About half of the full-time faculty were involved to some degree with the site visit team.

INDIRECT COSTS

Indirect costs are primarily the nonmonetary expenses that cannot be measured with dollar signs, but nevertheless have a significant impact on the operation of the School. These costs were analyzed by measuring attitude changes in students, faculty and staff, and by detecting shifts in priorities from diversions of resources.

STUDENTS

Almost 70 percent of the Dental School student body responded to questionnaires distributed toward the completion of the self-study in May, 1980. Most students (80 percent) were aware that the self-study was being conducted, although less than 8 percent had an active role in developing and reviewing self-study reports.

Student attitudes about the self-study were measured in six areas. In each case, students were asked to rate the issue on a scale of 0 to 3. Scores around the midpoint (1.5) express neutral attitudes, while those above indicate positive attitudes and those below, negative.

The most positive ratings of all students combined were in instructional areas (see Figure 6). As a whole, students felt that faculty accessibility and quality of instruction were affected "some" to "not at all" by demands of the self-study. At the same

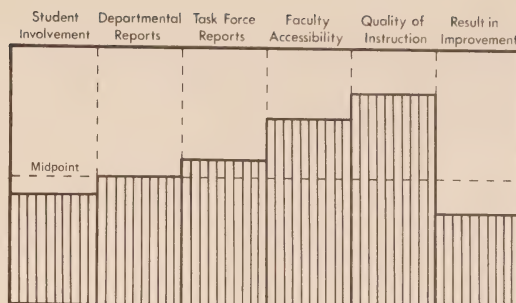


Figure 6. Student attitudes toward the accreditation self-study.

time students indicated that opportunities for student involvement were only somewhat available, and they were to some extent pessimistic about the prospects that the self-study process would result in improvements at the Dental School. Only students who had read the departmental and Task Committee reports responded to the second and third areas. These students indicated that the Task Committee reports were more responsive to student concerns than departmental reports.

None of the student groups—Dental Hygiene, Accelerated Professional Training (APT) or the four-year DDS—appeared to be predominantly negative or positive, although Dental Hygiene students had more positive outlooks in three of the six areas measured (see Figure 7).

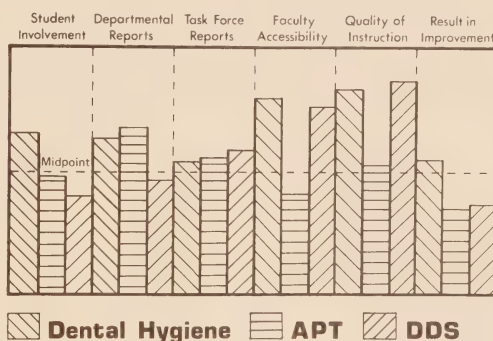


Figure 7. Comparison of attitudes of students in DH, APT and DDS programs.

Statistical differences among the three groups were found in their attitudes toward student involvement, expectations of improvement, faculty accessibility, and quality of instruction. No differences were found among the groups in attitudes toward department or Task Committee reports. Extreme differences were found in APT student

attitudes towards faculty accessibility and quality of instruction. The high level of involvement of full-time faculty in the APT self-study had a definite impact on teaching, according to APT students.

A questionnaire measuring the attitudes of faculty toward the self-study and its effect on their work was distributed at the October 1980 Faculty Retreat. Almost half of the faculty responding to the survey indicated that research in the Dental School had been most affected by the self-study, with 18.7 percent finding instruction most affected, and 9.3, service (see Figure 8). More than 25 percent of the faculty indicated that accreditation had no significant impact on their work.

Faculty also specified the extent to which accreditation affected various areas of responsibility. Overall, attitudes of the DDS faculty towards the impact of the self-study on faculty accessibility, quality of instruction, research, and service were positive (see Figure 9). Attitudes toward the extent of student involvement were neutral, while feelings were slightly negative toward expectations of improvements resulting from the self-study.

Faculty responses differentiated between the impact of accreditation on a school-wide basis and on individual areas of responsibility. In every instance, the faculty were more positive toward the effect of accreditation on individual areas than on school-wide areas. They perceived that their own

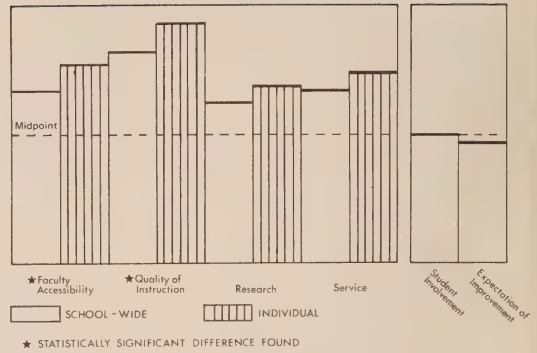


Figure 9. DDS faculty attitudes toward the impact of accreditation on school-wide and individual areas of responsibility.

work had not been affected as much as that of their colleagues.

Through a series of agree/disagree statements, faculty also expressed their attitudes about the effectiveness of the Dental School's self-study process and its usefulness as a mechanism for change. Responses to statements about the committee structure and length of time spent were combined to get an overall view of faculty impressions about the organization of the self-study (see Figure 10). For the most part, faculty were neutral about the effectiveness of the self-study organization. While

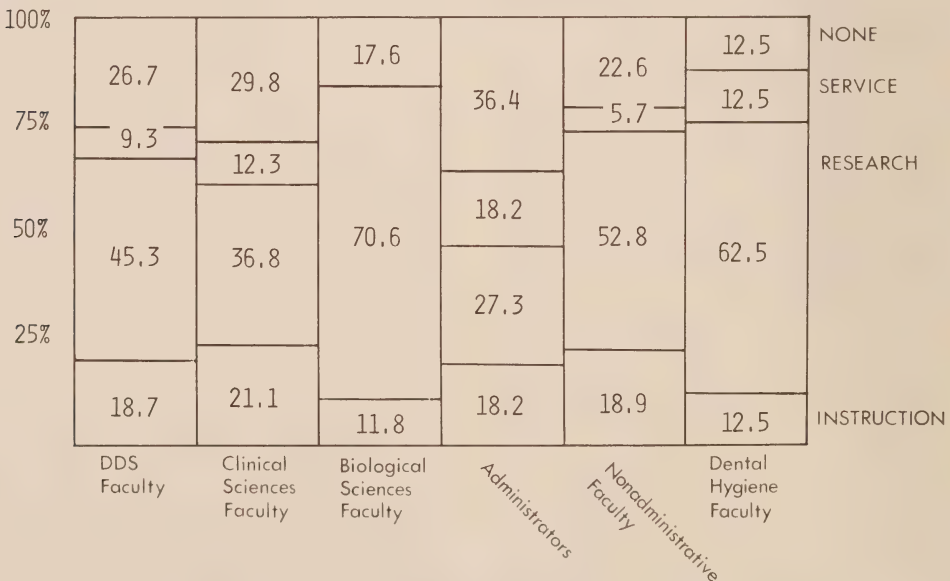


Figure 8. Areas of school-wide responsibility most affected by the accreditation self-study.

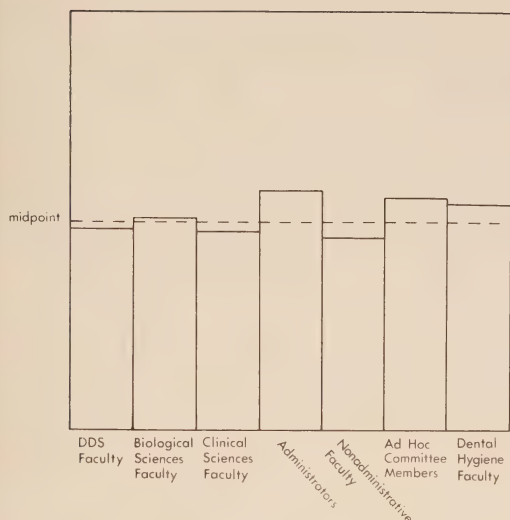


Figure 10. Faculty attitudes toward the organization of the self-study.

faculty agreed that the self-study committee structure was adequate, they also felt that the time and importance assigned the self-study were too great. Administrators, who were more heavily involved, tended to be more positive than nonadministrative faculty.

Responses to statements about increased faculty pride, curriculum changes, administrative responsiveness to faculty, and increased communication were combined to demonstrate faculty attitudes toward the usefulness of the self-study as a mechanism for change. Again, the faculty as a whole were neutral about the prospects of changes occurring at the Dental School as a result of the self-study (see Figure 11). Dental Hygiene faculty were somewhat more positive than the DDS faculty, probably due to the size of both groups. The smaller Dental Hygiene faculty, which had a high level of participation, were more likely to implement changes as a result of the self-study.

Most faculty agreed that administrators learned more about the School's weaknesses and that communication had increased as a result of the self-study. Only about half, however, felt that faculty pride had increased, and even fewer agreed that curriculum revisions would occur. (Curriculum review surfaced as the key issue in the self-study.)

SECRETARIAL STAFF

In addition to the faculty survey, a questionnaire was designed and distributed to secretaries in

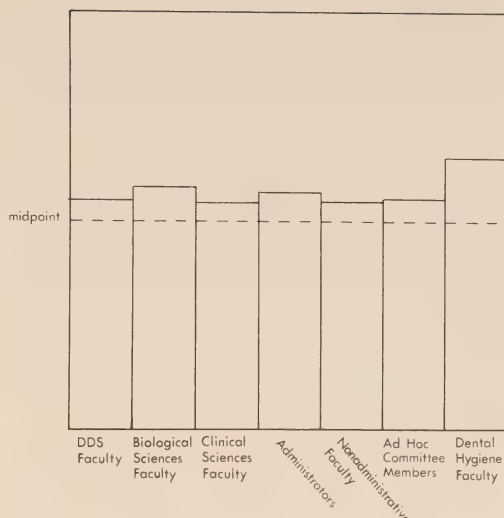


Figure 11. Faculty attitudes toward the likelihood of change resulting from the self-study.

October 1980 to determine which areas of their regular responsibilities had been most affected by accreditation. They indicated that instructional support work was most affected by accreditation demands. About a fourth of the secretaries, however, indicated that accreditation had no significant impact on their work.

On the whole, secretarial attitudes toward accreditation were neutral, although differences between departmental and other secretaries were evident (see Figure 12). The most negative attitudes were expressed towards the interference of accredi-

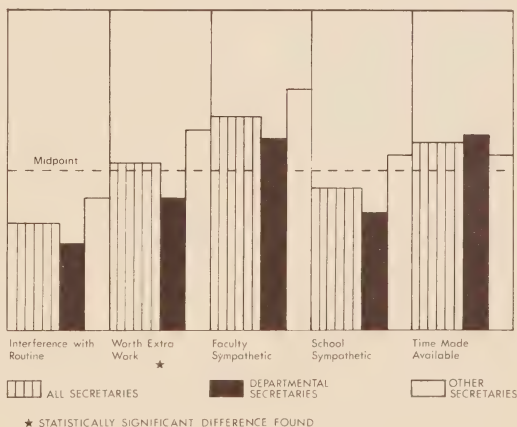


Figure 12. Secretarial attitudes toward accreditation.

tation with routine tasks. Secretaries were much more positive in their perception of faculty sensitivity toward their increased workload, as opposed to the sensitivity of the school (administrators).

DISCUSSION

The \$200,000 direct costs for the Dental School's 1981 accreditation site visit may or may not seem exorbitant, depending on a person's perspective. Many students felt it was a high price to pay, especially since expectations of improvement were so low. Faculty, however, estimated that the cost would be much higher. The range of costs for the self-study—\$160,000 to \$180,000—was 2½ to 3 percent of the total Dental School budget of \$6 million for FY 1980.

In analyzing the direct and indirect costs of accreditation, several observations should be considered in preparing for future site visits. For example, disparities in levels of faculty responsibility should be recognized in scheduling self-study activities. Further, while most students indicated a need for greater involvement in accreditation activities, few availed themselves of broad invitations to participate. Thus it appears that students are not likely to take the initiative to respond on an individual basis to general invitations, but would be willing to accept responsibility that is clearly defined.

Although not addressed in the *Self-Study Manual*, communication with the use of secretarial support staff is an important element in the overall process. Lack of direct communication often led to confusion and resentment among many of the secretaries, especially those in departments. Regularly scheduled informational sessions for secretarial staff might have reduced the confusion and improved morale.

Because it is difficult to quantify the benefits of accreditation, a judgment of the \$200,000 cost is difficult to make. The costs to the University of Maryland Dental School, both direct and indirect, seem to be in balance with the benefits. However, if the conditions of accreditation were to change, i.e., increased requirements or decreased time between site visits, the benefits may be outweighed by the costs, especially the indirect costs.

The only certainty is that the costs of accreditation are real and should no longer be ignored by either the Commission on Accreditation or dental schools facing site visits. Because accreditation does draw resources from other areas of operation, the process should be efficient in its continuing effort to maintain standards and foster excellence.

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Accreditation Process: Its Effectiveness at the University of Maryland Dental School

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ABSTRACT

The self-study structure established by the Commission on Accreditation was, for the most part, followed. Faculty expressed neutral feelings about the effectiveness of the self-study organization and felt the self-study structure was adequate. Although the Dental School shortened the suggested self-study time frame from 72 to 40 weeks, faculty still felt too much time was assigned to the self-study.

Self-study committee members had difficulties interpreting many questions in the Self-Study Manual. Questions seemed ambiguous, duplicative, and needlessly far-reaching. Committee members also felt that the Self-Study Manual seemed to be a compilation of individual efforts with little comprehensive focus on editing.

Faculty, about 70 percent served on self-study committees, were positive about their involvement. Yet, faculty in general felt neutral about the likelihood of change resulting from the self-study.

Accreditation can be viewed by institutions either as a tool for improvement or as necessary busywork. No matter how it is perceived, accreditation demands institutional attention. However, the extent to which accreditation activities affect a school and its faculty, staff, and students can be determined by these perceptions.

Every seven years, accredited dental schools in the United States are visited by the Commission on Accreditation of Dental and Dental Auxiliary Programs. The Commission provides general guidelines for collecting information and conducting the required self-study. Although each dental school determines its own procedures, informational requirements necessitate some if not a great deal of similarity in the procedures. It may be valuable for schools developing accreditation methodologies to look at the effectiveness of another school's accreditation process.

In conjunction with a study of accreditation costs at the University of Maryland Dental School, an assessment was made of the accreditation self-study process that led to the January 1981 site visit. The study was jointly funded by the American Fund for Dental Health and the Dental School. In the following discussion, three areas concerning the process will be addressed:

- 1) Effectiveness of the self-study structure
- 2) Effective use of personnel and students
- 3) Usefulness of the self-study as a mechanism for change.

For the most part, the Dental School followed the guidelines recommended in the Commission's *Self-Study Manual*. Differences will be noted when appropriate.

PLAN OF ORGANIZATION

The overall accreditation process from the planning stages to the site visit took about 18 months. Administrative planning began in August 1979, and the self-study was completed by August 1980. The months between the completion of the self-study and the actual site visit in January 1981 were used for binding and sending reports to appropriate sources, collecting additional information, making displays, and implementing self-study recommendations.

The self-study took place primarily in 1979-80, the academic year preceding the site visit. An ad hoc Committee on Accreditation was appointed by the School's Executive Committee in October 1979, one month prior to the initiation of the self-study. The responsibilities of the Committee were to develop a timetable and to establish guidelines and procedures to be followed during the self-study.

The ad hoc Committee was comprised of a cross section of faculty, students and administrators. A majority of Committee

members also served as chairmen of Task Committees responsible for developing reports as specified by the accreditation body. About half of these Task Committees were already in existence as standing committees of the Faculty Council. The Committee structure was dictated for the most part by the different sections in the *Self-Study Manual*. Preparation of certain portions of the report involved personnel outside the School, such as University financial and library personnel. In addition to the individual Task Committee reports, a self-study report was prepared by each department.

The faculty were introduced to self-study materials and committee selections at a Faculty Retreat in early October 1979. Task Committees and departments began meeting in November to plan their study methodology. First drafts of the self-study reports were due in March, four months later. Although most reports were completed by the March date, a few were submitted approximately 2 weeks late.

Review subcommittees, made up of ad hoc Committee members and other faculty, read the reports and submitted recommendations for changes to Task Committees and department chairmen during March and the first of April. Revisions were made and reports were resubmitted in April and May. Final reviews were concluded in May and June.

After reviewing all of the reports and recommendations, the ad hoc Committee identified major issues that related to the School as a whole. The issues identified by the ad hoc Committee were presented as recommendations and discussed at a second Faculty Retreat in October 1980. The faculty ranked the recommendations and recommended methods to be utilized in accomplishing the recommendations.

EFFECTIVENESS OF SELF-STUDY STRUCTURE

Several different methods were used in analyzing the effectiveness of the self-study organization. Faculty impressions were solicited by means of a questionnaire and through interviews; observations were made throughout the study; data requirements were analyzed; and the usefulness of the *Self-Study Manual* was probed.

An aspect of a faculty questionnaire was designed to measure faculty attitudes concerning issues related to the organization of the self-study, the level of faculty and student involvement in the self-study, and the likelihood that the accreditation process would bring about improvements in

the dental program. Faculty were asked to indicate their level of agreement or disagreement with statements on these issues. The response of neutral was not provided in order to force definitive response.

The faculty generally expressed neutral feelings about the effectiveness of the self-study organization (see Figure 1). In Figures 1–3, the higher the bar, the more positive the attitude. The mid-point indicates neutral feelings. The neutral ratings resulted from a cancelling out effect between certain issues. While faculty felt the committee structure was adequate, they also felt that too much time and importance were assigned to the self-study. Administrators, who developed the structure and were heavily involved, were more positive about the organization than nonadministrative faculty. The effectiveness of the self-study structure was evaluated not only through questionnaire results, but also through observations made at formal and informal meetings and in conversations with various faculty members.

The procedure used by the Dental School varied somewhat from the procedures suggested by the Commission on Accreditation. The time frame was shortened from the suggested 72 weeks to about 40 weeks. In an analysis of time periods, it appears that the three-month period for editing and typing was lengthy in comparison with the four months provided for compiling the first draft.

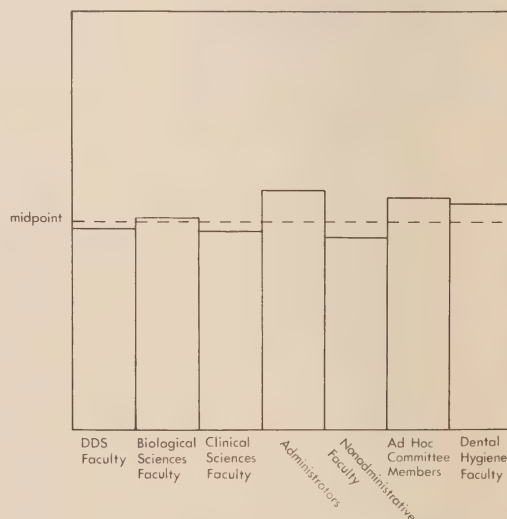


Figure 1. Faculty attitudes toward the organization of the self-study.

However, according to actual time spent by month, much of the work was actually compressed into two months, the last two months before reports were due. While some committees and departments, especially those with more extensive reports, might have used a longer time span, perhaps much of the work would have been delayed to the last two months anyway.

In addition, the length of the review period was due in part to the poor quality of some of the reports. Several departmental reports had to be almost totally rewritten. The volume of reports also required a great deal of reading before revision could be discussed.

The major work of the self-study was accomplished through the committee structure. Usually the primary work was performed by individuals outside of committee meetings and later was reviewed by the full membership. This format often led group discussion from substance to trivia, such as punctuation and wording.

Makeup of the committees was also important. The actual information requested in the *Self-Study Manual* generally could have been provided by a few administrators. However, having a representative group of faculty and administrators evaluating the information sometimes created productive controversies. The mix of committee viewpoints was a definite strength in most cases. A greater understanding of problems and issues seemed to emerge from the combined efforts of both administrators and faculty.

The *Manual* recommends that a small ad hoc Committee oversee the self-study and develop the school-wide recommendations. It also suggests that the ad hoc Committee members have only limited involvement in the actual self-study. In order to expedite communication, the Dental School chose an ad hoc Committee composed of the chairmen of the Task Committees, all deans, other junior and senior faculty and students. The membership totaled 22 faculty and 2 students. A secretary also attended all meetings as recorded. At the initial ad hoc Committee meetings, time was spent developing the format of the report, including appropriate margins and headings. Discussions of revisions in format later obstructed progress at many of the meetings.

On the other hand, the organization of the self-study, including the committee structure and use of review subcommittees, facilitated the accomplishment of its primary goal, the involvement of a wide range of faculty. From the survey, almost three

fourths of the faculty indicated that they participated in at least one of these groups during the year. Only in the preparation of some departmental reports was there a lack of group discussion. From time sheets and self-study methodologies, it is obvious that some departmental reports represented the work of only one or two people and an absence of any real evaluation. In most cases, however, there was a real effort to examine the strengths and weaknesses of the School.

1. *Self-Study Manual of the Commission on Accreditation*

Many committees had difficulties interpreting questions in the *Self-Study Manual*. Because the Dental School's organizational structure is complex—with DDS, graduate, Advanced Specialty Education and dental hygiene programs—it was difficult to view questions from all of these vantage points.

Most Task Committee members also were unaware of requirements in other sections of the *Manual*, thus unnecessary duplication resulted. Many questions were ambiguous and needlessly far-reaching. Often Committee members had to interpret a question before it could be answered. If every question in the first section, for example, were viewed in the broadest context, there would have been no need for many of the questions in the remaining sections. The *Self-Study Manual* seemed to be a compilation of individual efforts with little comprehensive focus or editing. A conscientious attempt to provide thorough answers to all the questions was made more difficult with this confusion. Although the questions should be comprehensive enough to assist a school in its self-study and the site visit team in its assessment, eliminating repetitious questions would prevent committees from duplicating effort and vital information from being lost.

2. *Data Collection*

Most of the data used in the self-studies came from surveys designed specifically for accreditation or were compiled to satisfy requirements of specific tables in the *Self-Study Manual*. Occasionally, data collected for other purposes were utilized in the study of accreditation issues. Accreditation also became the impetus to satisfy prior requests for information.

Surveys were used to collect data and attitudinal information from faculty and students. A total of 13 questionnaires were distributed by seven Task Committees. The use of surveys and interviews varied among the committees. Often the questionnaires used ambiguous language or sim-

ply lifted wording from the *Self-Study Manual*. For example, faculty were asked to evaluate on one scale; administration, "in terms of function and performance." Factual and attitudinal data were, for the most part, available; however, it was not always used effectively in evaluations.

3. Effective Use of Personnel and Students

Faculty tended to be positive about the opportunity for their involvement in the self-study (see Figure 2). In every instance, the attitude ratings of faculty groups were above the midpoint. Those with greater involvement seemed to be the most positive.

About 70 percent of the faculty indicated that they had served on a self-study Task Committee or a Review Subcommittee. In addition, most faculty were involved in compiling departmental self-study reports. If the department chairmen utilized their faculty well, every full-time faculty member would have assisted in at least one area of the self-study, not including time spent responding to questionnaires.

Faculty also were asked if they agreed or disagreed that opportunities for students to affect the educational process were increased during the self-study. Slightly more than 60 percent of the DDS faculty agreed.

In most cases, there was little student involvement in the accreditation study. About 7 percent of the DDS students indicated that they were actively involved in self-study committees. Students also

were informed that both Task Committee and departmental reports were available for review, and copies of all first drafts were sent to class presidents.

Student members of some of the Task Committees provided significant input, not only participating in committee discussions, but also carrying part of the individual workload. Little student involvement, however, was solicited in the preparation of departmental reports. More than 80 percent of the students who knew about the self-study indicated that more students should have been involved.

If student input is important, the key to greater involvement appears to be structure. Students are not likely to take the initiative to respond individually to broad invitations. They do appear willing to take on tasks that are clearly defined.

The secretarial staff indicated that better communications would have decreased their workload and improved attitudes. Although some secretaries enjoyed their role in the self-study, others were resentful of the additional responsibilities.

The Dental School's secretarial and support staff had almost no direct voice into the self-study. While lack of staff input was often appropriate in view of the subject matter, the staff might have had valid insights into facility use and problems on the clinic floor. If communication lines were open, their views might have been voiced indirectly.

4. Mechanism for Change

The benefits of a successful self-study should reach far beyond a positive accreditation rating. If a school has seriously studied its operation, changes should occur to reinforce strengths and eliminate major weaknesses.

Overall, faculty groups felt neutral about the likelihood of change resulting from the self-study (see Figure 3), with DH faculty being significantly more positive than DDS faculty.

Over three quarters of the DDS faculty agreed that administrators learned more about the shortcomings and needs of the School and that communication within the School had improved as a result of the self-study. However, only about half agreed that the self-study increased faculty pride in the School's quality, and less than half (45 percent) agreed that changes in the curriculum would result from the self-study.

It is impossible to divorce the self-study completely from the past or the dynamics of the present. Old prejudices, fears, pet ideas and biases have an impact not only on the self-study report, but also on the process itself. Self-examination may

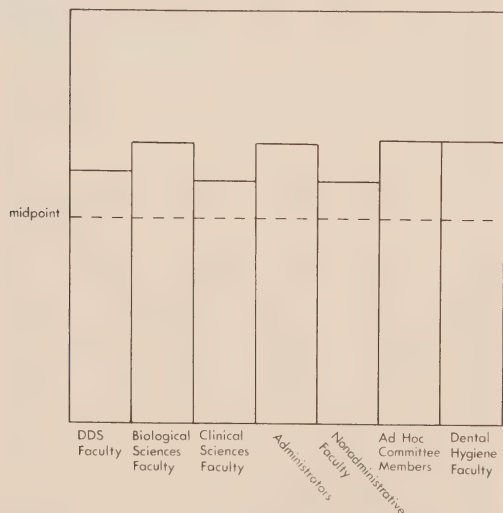


Figure 2. Faculty attitudes toward opportunity for faculty involvement in the self-study.

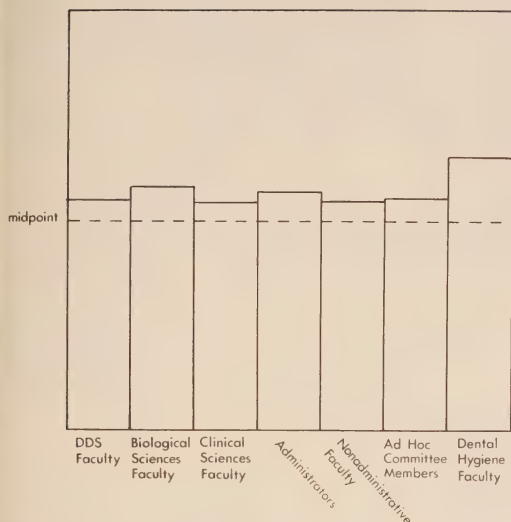


Figure 3. Faculty attitudes toward the likelihood of change resulting from the self-study.

not always provide new insights. On the other hand, the process may force issues to surface instead of being ignored or allowed to exist through a series of non-decisions. In addition, the self-study provides a framework for investigating long-range issues. In the day-to-day operation of any institution, this kind of reflection often get pushed aside for more pressing needs.

Although the faculty felt neutral about the likelihood of change or improvements resulting from the self-study, changes have indeed taken place. Whether or not these changes will lead to an improved program remains to be seen. The self-study, however, can be an impetus for change if institutions allow it to be.

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I. GENERAL INFORMATION

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One original and two copies of manuscript with illustrations should be sent to the Editor-in-Chief, The Journal of the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore, 666 W. Baltimore Street, Baltimore, Maryland 21201. The articles which are submitted for publication are expected to follow the format suggested below. It is assumed the papers are based on original data.

II. TEXT SECTIONS

Each article should be sequentially arranged as follows:

- A. Abstract
- B. Introduction
- C. Materials and Methods
- D. Results
- E. Discussion
- F. Acknowledgements
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III. MANUSCRIPTS

Manuscripts must be typewritten on one side only, double spaced with liberal margins of all text material, references, and legends. Manuscripts ordinarily should not exceed 10 to 12 double-spaced typewritten pages (excluding references, figures, and tables). Include a title page with the title of the manuscript and complete author(s) identification, including name, degrees, title or academic rank, institutional affiliation and address.

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Fibrillogenesis in the Dental Sac, *The Journal*,
21:55-63, 1966.
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Doe, J.J., and Brown, D.M.: *Inheritance and
Development* (Edited by White, S.T.), Chap. 1,
p. 16, University Press, Baltimore, 1966.
- C. References in press or personal communication.
Doe, J.J.: Fibrillogenesis in the Dental Sac,
The Journal (in press), 1966.
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Original drawings should be prepared in black India ink. Typewritten or freehand lettering is *not* acceptable. All lettering must be done professionally. Do not send original art work or x-rays. All illustrative material should be submitted as 5" x 7" glossy photographs. For good black and white reproduction, contrast is essential. Illustrations will not be returned unless specifically requested. All illustrative material *excluding tables* should be indicated as figures. Each illustration should be keyed to the text and numbered consecutively. The back of each photograph should bear the following information: figure number, descriptive information, author(s) and reference to top of illustration. Descriptive information for figures should be concise but include all pertinent information, e.g. technical data such as stains or magnification. NOTE: Color photographs will be accepted only if the author agrees to pay the additional cost for their reproduction.

VI. TABLES

All tables will be type-set and should be keyed to the text and numbered consecutively with Arabic numbers, e.g., Table I. Be sure all descriptive information associated with the title of the table is concise.

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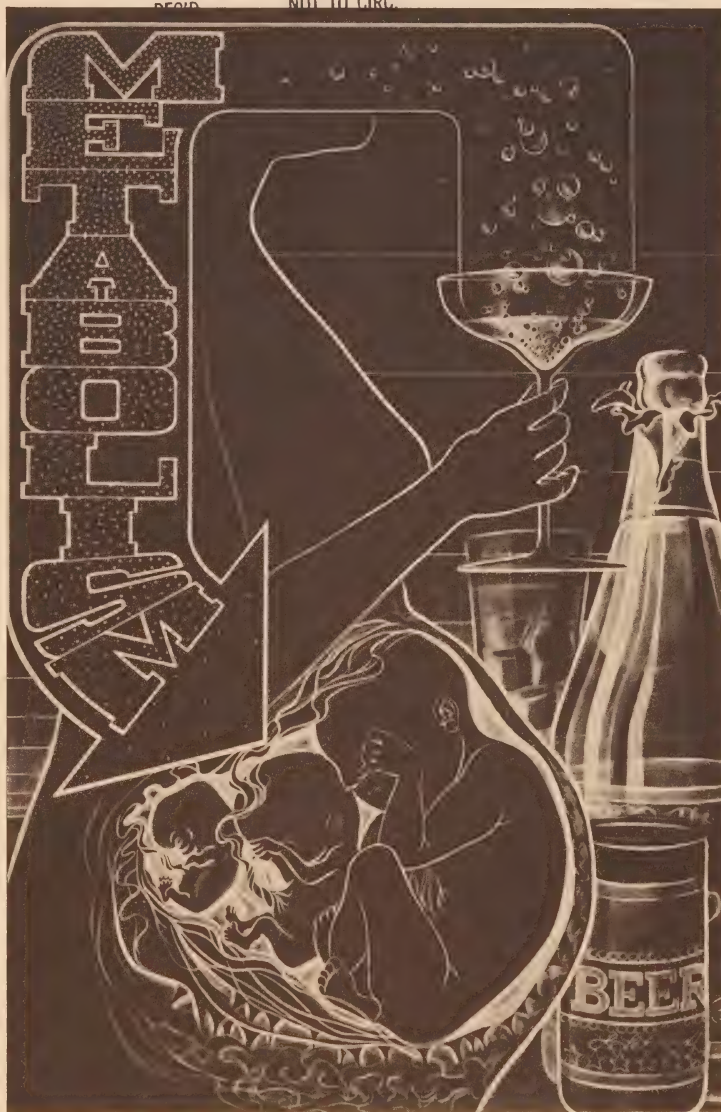
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 By: Leslie LeCroix



Dean Errol Reese has appointed Dr. Richard J. Smith, Associate Professor and Director of the Postgraduate Program in the Department of Orthodontics as Editor-in-Chief of the *Journal*, replacing Dr. Donald E. Shay, who retired June 30, 1981.

Dr. Smith received a B.A. degree in psychology from Brooklyn College of the City University of New York in 1969, and was awarded his D.M.D. from Tufts University in 1973. While at Tufts, he also earned an M.S. in Anatomy. From 1973 to 1976, Dr. Smith studied orthodontics at the University of Connecticut, and did research on a National Institute of Dental Research Postdoctoral Fellowship. While serving as a Clinical Assistant Professor of Orthodontics at the University of Connecticut, he enrolled in full-time graduate study in Anthropology at Yale University, earning a M. Phil. in 1978 and a Ph.D. in 1980. During these studies, Dr. Smith was recipient of a Teacher Training Fellowship from the American Fund for Dental Health.

Dr. Smith joined the faculty of the Baltimore College of Dental Surgery in July, 1979. He is a member of local, state, and national organizations in dentistry and orthodontics, as well as the Academy of Dentistry for the Handicapped, the International Association for Dental Research, and the American Association of Physical Anthropologists. He lives in Baltimore City with his wife and two children.

Non-Ossifying Fibroma of the Mandible: Report of a Case

Jon K. Park, D.D.S., M.S.
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Joseph B. Hanley, Jr., D.M.D.

ABSTRACT

The non-ossifying fibroma is a radiolucent lesion of bone which is relatively common in long bones but rarely seen in the jaws. The lesions are usually asymptomatic and are occasionally bilateral. They present radiographically as well defined radiolucencies and are usually solitary and occasionally may appear multilocular. The most characteristic features of the non-ossifying fibroma are histologic; these features include a swirling appearance of the fibrous connective tissue stroma, presence of spindle-shaped fibroblasts, multinucleated giant cells in the stroma, foam cells, and an absence of any sign of bone formation. The present article discusses the history, clinical features, etiology, radiology and histology of the lesion. A case report of non-ossifying fibroma of a 21 year old female is reported.

INTRODUCTION

Non-osteogenic, or non-ossifying fibromas are relatively common in long bones;^{1,4} but are extremely rare in other areas of the skeleton.⁵⁻¹⁰ The present case is of a non-ossifying fibroma of the mandible.

REVIEW OF LITERATURE

History: The non-ossifying fibroma was initially studied by Jaffe and Lichtenstein in 1942.¹¹ Their study was limited to lesions of long bones (especially the femur) which demonstrated definite radiographic characteristics. According to many investigators these features were sufficiently pathognomonic for making a definitive diagnosis.^{1,2,11}

The lesion has been called by many names. Prior to the 1942 study of Jaffe and Lichtenstein, the lesion had been described as "cyst-like" by Sontag and Pyle,¹² and a "giant cell variant of a bone cyst" by Geschickter and Copeland.¹³ Other terms included "fibroblastic variant" or "healing variant" of a giant cell tumor, and "xanthoma" or "xanthogranuloma of bone."²

Subsequent to the work of Jaffe and Lichtenstein,¹¹ several investigators suggested changes in nomenclature. Because the lesions were consistently found at the metaphyseal ends of long bones, the term "fibrous metaphyseal defect" was proposed.^{14,15} However, other investigators have shown that these lesions may occur at other sites.³

Clinical Features: According to Jaffe and Lichtenstein, the average age of occurrence for these lesions is approximately 16, with a range of from 8 to 20 years of age. Others have reported cases of non-ossifying fibroma in patients as young as 2 years old¹² and as old as 50.⁹

These lesions are usually asymptomatic,^{1-2,4,7,12,14} occasionally bilateral,² and are frequently found on routine radiographic examination of the skeleton. If the lesion produces symptoms, these are often of short duration, usually being only two or three weeks prior to examination.¹¹ The usual symptom, if any, is tenderness over the site of the lesion or pain upon palpation.^{11,16} Occasionally pathologic fractures may occur prior to medical evaluation—especially when the lesions are located in long bones.^{5,12}

The lesions tend to be self-limiting.^{4,15} They may develop, regress and disappear after one to four years of duration.^{2,12-14} There appears to be no sex predilection,¹⁵ although some studies indicate a preponderance of males.¹²

Etiology: The non-ossifying fibroma is considered by most investigators to be non-neoplastic in nature,^{1,4,17} and while the etiology is unknown, various causative factors have been suggested, such as a developmental defect,^{1,4,17} a bone defect due to regional

ischemia of the part,⁴ a metabolic defect of a bone, a variant form of fibrous dysplasia,^{20,21} and a variant of an early osteoma.^{8,12} Some investigators state that the non-ossifying fibroma represents an intermediary between the giant cell tumor and the solitary bone cyst of osteitis fibrosa.¹³ Schott and his colleagues think the lesion represents the equivalent in long bones of the reactional giant cell granuloma of the jaw.¹⁹

Radiology: Radiographically, the non-ossifying fibroma has been described as a radiolucency frequently demonstrating a relatively well-defined, thin, radiopaque border.^{1,2,5,8,9,12,22} It may occasionally have a multilocular appearance.²³ The lesion is usually solitary and does not demonstrate opacification within the radiolucent space. The radiographic appearance of the typical non-ossifying fibroma, when found in its usual sites within a long bone, and when correlated with accompanying clinical findings, are usually sufficient to make a diagnosis.^{1,2,11,22} Schlumberger reviewed 67 cases of fibrous dysplasia and found 12 cases which could not be differentiated from non-ossifying fibroma.¹⁸ The lesion most commonly assumes a size from about 2 to 7 centimeters; when found in long bones, it is ovoid and parallel to the long axis of the bone.¹⁷

Histology: Histologically the lesion shows certain features which aid in its diagnosis. They are: 1) whorled appearance of the fibrous connective tissue stroma, 2) presence of a number of typical spindle-shaped fibroblasts, 3) presence of multinucleated giant cells in the stroma—probably resulting from a consolidation of individual fibroblastic components, 4) a variable component consisting of foam, or xanthoma, cells (in earlier studies these were the "xanthic variants", which contributed to the etiologic confusion of this condition)^{1,2} and 5) absence of production of any bone within the lesion.^{2,3,8,11,24} Some investigators have stated that the histologic appearance may be "very disturbing" and may resemble that of a fibrosarcoma.^{6,9} This appearance is attributed in large part to the abundance of fibroblasts, the production of collagen, and the tendency for these components to assume a whorled appearance. The lesions are benign, fibroblastic in nature, and show only secondary characteristics histologically related to either presence of giant cells or the lipid deposition in the cells. The lesion tends to favor formation of either the giant cell component or the foam cell component; usually these two components are not formed with equal degree in the same lesion.²

In general, the lesion appears benign and does not undergo malignant transformation; however, one case has been reported which was claimed to have undergone malignant transformation,⁴ and occasion-

ally cases have been reported as having co-existing malignant features along with the non-ossifying fibroma.^{20,21,25,26} One case has been reported which supposedly had neurofibromatosis of bone in conjunction with the non-ossifying fibroma.²⁷

Jaffe and Lichtenstein considered the xanthic, or foam cell component to be due to a simple biochemical degradation of the stromal tissue, the fibroblast, the remains of which would yield the foam cell.¹¹ Currently the most widely accepted concept seems to be that the fibroblast may either proliferate and yield giant cells or imbibe lipid and produce foam cells.^{2,3}

Fibrous Cortical Defect: A related entity, the fibrous cortical defect, is a very common lesion which represents a primordial form of the non-ossifying fibroma.^{2,28} Usually the fibrous cortical defect is located near the metaphyseal cortex of long bones, most frequently the distal metaphysis of the femur. It erodes the cortex at the site, rarely produces symptoms and usually disappears spontaneously.²

Differential Diagnosis: The non-ossifying fibroma must be differentiated from other similar radiolucent lesions such as central giant cell granuloma, fibrosarcoma, solid ameloblastoma, fibrous dysplasia, neurofibroma, desmoplastic fibroma or fibromyxoma.^{9,43-45}

Treatment: The usual treatment for this lesion when found in the jaws is surgical enucleation. The rationale for this is that the lesion can not be differentiated radiographically from other more aggressive entities—especially when it is located in the facial region. When the lesion is detected in a long bone, there is usually no treatment unless symptoms accompany the radiographic findings.¹² Generally resolution occurs within a few years; thus, no treatment is indicated. However, some individuals have advocated curettage when this lesion is detected.^{5,16}

CASE REPORT

A 21-year-old white female was referred for removal of four third molar teeth. Upon radiographic examination, the patient exhibited a radiolucent defect located mesial to the mandibular left third molar. The lesion appeared purely radiolucent and in association with the left third molar (Figure 1). The radiolucency was circular, well-circumscribed, and was approximately 0.5 cm. in diameter. The tentative diagnosis of dentigerous cyst was made.

The patient presented no symptoms related to the lesion and the duration of its existence was unknown. No laboratory tests were requested. Other than a history of low blood pressure, the patient's past medical history was unremarkable.

Clinically, the lesion was not visible; there was no evidence of alveolar expansion. A 5% solution of dex-



Figure 1: Pre-operative radiography of radiolucency which appears to be associated with the mandibular left third molar. (At the time of surgery, the lesion appeared to have no contact with the third molar. It had destroyed the cortex and was lateral to the tooth.)

trose in water was administered intravenously in conjunction with 10 mg. of Valium and 0.4 mg of atropine sulfate. These drugs were administered prior to the initiation of anesthesia. An intravenous titration of Brevital sodium, 150 mg., was administered throughout the surgery. The patient also received four carpules of local anesthetic, Xylocaine 2% with epinephrine, 1:100,000.

The four third molars were removed and the lesion enucleated without complication. The tissue appeared gelatinous and was immediately placed in 10% neutral buffered formalin. Clinically, the lesion appeared to have no contact with the third molar. It had destroyed the cortex and was located lateral to the tooth.

Sutures were placed and the patient was dismissed. The patient was examined 5 days post-operatively, and all healing appeared to be taking place without complications. The patient was not re-examined until four months had lapsed. At that time, post-operative radiographs were exposed. There were no significant findings during the follow-up examination.

Gross sections submitted for histologic examination consisted of several formalin fixed pieces of gelatinous soft tissue measuring $0.4 \times 0.3 \times 0.2$ cm. in aggregate. Upon microscopic examination, the typical pattern of non-ossifying fibroma was apparent. Whorled fibrous connective tissue, multinucleated giant cells, foam cells, and a consistent lack of any evidence of calcification could be demonstrated. (Figure 2, 3). The diagnosis was non-ossifying fibroma, mandible.



Figure 2: Photomicrograph of biopsy specimen taken from area of radiolucency shown in Fig. 1. Typical whorled appearance of fibrous connective tissue and multinucleated giant cells are demonstrated. (Hematoxylin and eosin. Magnification X100).

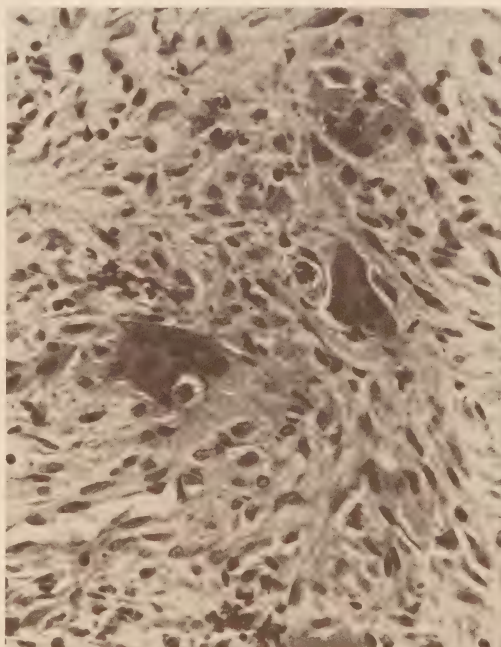


Figure 3: Higher power magnification of non-ossifying fibroma showing multinucleated giant cells and fibrous connective tissue stroma. (Hematoxylin and eosin. Magnification X250).

DISCUSSION

While the non-ossifying fibroma is a relatively common lesion in long bones, it is extremely rare in other areas of the skeleton. The present review of literature yielded only 13 cases within the jaws.^{6,8,9,10,29-32} Other similar cases in facial bones have been reported, but the description relative to true diagnosis of a non-ossifying fibroma is questionable.³³⁻⁴² Some individuals attribute the rarity of this lesion in the jaw to the possibility that the lesions become transformed into the more common ossifying fibroma before they are detected, and before they are removed, bone has already started to form.^{7,37}

As previously mentioned, the lesion tends to favor formation of either a giant cell or a foam cell component, generally in unequal amounts. In the present case, while both components could be demonstrated, there was a predominance of the giant cell component.

SUMMARY

A case report of a rare jaw lesion, the non-ossifying fibroma, has been reported. Only 12 cases of similar lesions have been published previously. Non-ossifying fibromas tend to appear as asymptomatic radiolucent lesions having a characteristic histology. Since they can mimic many other pathologic entities when found in the jaws, it is recommended that they be surgically removed.

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The Accelerated Professional Training Program: Rationale and Observations on Alterations in the Preclinical Experiences

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ABSTRACT

Many undergraduate dental curricula have attempted to increase student motivation by scheduling earlier and increased clinical exposure. The University of Maryland's Accelerated Professional Training Program has developed a course of instruction which is specifically designed to include early clinical experience through significant alterations in the content and sequencing of the preclinical component of the program. Because of the educational limitations inherent in technique courses, the time commitment and scope of learning objectives for preclinical exercises were reduced. This caused a shift of teaching emphasis to the clinical environment. The preclinical technique course emphasized a self-paced, self-instructional design which allowed immediate utilization of learned material through simultaneous clinical experiences.

INTRODUCTION

For the past several years, dental curricula have placed considerable emphasis on the early introduction of undergraduate students into the clinical environment, for both motivational considerations and more effective teaching potential. Anderson has suggested that students absorb instruction at a faster pace when they reach the clinical patient stage,¹ while Schield finds that to develop motor skill potential properly, students must have the motivation received from contact with patients early in their dental school experiences.² The increase in clinical exposure, when associated with modifications in the preclinical component of instruction, produces positive changes in both student attitudes and performance.³ More curricula are becoming flexible in this regard with acceleration in student-patient contact and increased efforts toward earlier applications of principles introduced to technique courses.

At the University of Maryland Dental School, the Accelerated Professional Training Program (APT) was established in 1972 as a small, experimental model of dental education, distinct in several areas from other curricula.⁴ One of the primary objectives of the program is early and increased student clinical exposure.⁵ Toward this objective significant alterations in the content, methodology, and sequencing of the preclinical technique experiences were proposed and implemented.

DISCUSSION

Custer³ has observed that one weakness found in the typical dental curriculum is that there is no apparent reason for the quantitative requirements of various technique laboratory courses. The number of times a student repeats a particular exercise does not seem to enhance motor skills as much as precise pre-operative understanding and clinical observation.² As a result, extensive preclinical exercises do not appear to provide for a degree of clinical preparation commensurate with the amount of time they consume in the undergraduate curriculum. In APT, a preclinical format was designed which would recognize the educational limitations inherent in the technique program and shift the major emphasis of instruction to the clinical environment.

In the APT preclinical program, the faculty strives to provide a minimum essential experience deemed adequate to insure student competence while permitting the earliest possible patient contact. The most significant change has been a reduction by approximately 70% of the hours designated for preclinical exercises in the conventional four-year program at Maryland. This reduction includes the elimination of duplicate exercises and projects not considered essential for proceeding on to patient treatment. Most importantly,

the reduction in time is made possible by an approach to student evaluation which de-emphasizes the mastery of certain manual skills. Conceptually, this relates back to the premise that the technique laboratory is not considered the best learning environment. It is the objective of the program to direct students through this section of the curriculum as rapidly as possible, leaving with them an understanding of materials and some basic skills and promoting them to patient care where instruction is more relevant and learning potential is accelerated.

The preclinical program utilizes a self-instructional approach for the majority of the required material. Only a limited number of laboratory sessions are formally scheduled, with the largest portion of work performed independently. Students are given direct responsibility for gathering information through referral to prepared manuals, specific behavioral objectives, and considerable amounts of audiovisual material. As a result, there is a significant degree of self-pacing through this section of instruction. The program is organized to provide for a large degree of flexibility in meeting deadlines. The faculty have found this organization to aid in producing an atmosphere of informality and to promote closer student-faculty relationships. In addition it eliminates much of the pressure associated with time limitations. These factors build a foundation for more individualization of instruction and much closer faculty supervision and understanding of specific student needs.

By the middle of their freshman year, APT students are assigned patients for complete denture construction and by May of the same term, they begin limited comprehensive care for as many as six adult patients. To provide the experiences necessary for this progression, first year students are assigned to upperclassmen for chairside assisting and observation of periodontal, restorative and treatment planning procedures. Thus, new students are immediately given the opportunity to observe periodontal disease, caries and malocclusions as well as the techniques and materials utilized in treating such conditions. This develops not only an appreciation for the pattern of general clinic policies but more importantly establishes a framework for learning which will be developed further in seminar discussions and preclinical exercises. This introduction to clinical activity prior to the presentation of the main body of instruction has been found to be a very effective motivational tool.

The specific sequencing of the preclinical program is arranged to provide for the immediate clinical utilization of learned material whenever possible. The schedule is developed to correlate the anticipated

need for information with the progression of the type and complexity of care being provided. As students begin comprehensive care, the pre-clinical sections of operative dentistry, endodontics, and occlusion are being completed. The course in fixed prosthodontics is scheduled early in the second year to enable students to treat patients with more advanced restorative needs during the spring semester of the same year. Students are thus providing care and gaining experience and confidence in several areas concurrent with the introduction of more advanced procedures.

If this methodology of instruction is to succeed, considerable importance must be placed on a continuity of clinical theory and teaching philosophy extending throughout the curriculum. As a means of accomplishing this, APT is staffed with a core faculty, acting as a team, which has major responsibility for both didactic and clinical teaching. The individuals who develop and supervise preclinical courses have direct control of the same disciplines in the clinic. While students may not be exposed to the diversity of techniques and styles that result from a rotating faculty, this offers a smooth, less stressful transition and has also been found to be an excellent means of effectively expanding upon the core of information received during preclinical exercises.

RESULTS

The APT Program has accepted an extremely diverse group of students with a broad range of academic credentials. Examination of Dental Aptitude Test scores and overall grade point averages reveals students who display qualifications ranging from very high to a level below the average accepted into the dental school's conventional program. After admission to the dental school, the main criteria for acceptance into the APT program has been a subjective evaluation by the faculty concerning the candidate's personality and ability to work in small groups and in close relationships with others. Of the 90 students who have matriculated into APT, there have been fewer than 5 who have required remediation in clinical disciplines through additional preclinical experiences. There has been no evidence that this has been a result of a basic inadequacy in the content or supervision of the technique course and no major changes have resulted. Proficiency examinations given in operative dentistry at the end of the second year of instruction and evaluated by faculty not associated with the APT Program have resulted in uniformly high grades and no failures.

Due to the team configuration of the faculty and the small size of the program, there has been a need for the staff to have complete or partial responsibility

in more than one treatment specialty. Some individuals are directly involved in the didactic, technique and clinical portions for three or more specific course areas. This multidisciplinary approach has been found to place greater demands on the faculty and has encouraged, if not required, their own professional development and expansion of knowledge.

Perhaps the most important result of the program can be found in student attitudes regarding their educational experience. Surveys of APT graduates⁶ reveal very positive opinions concerning the school itself and the method of instruction to which they have been exposed.

It is the belief of the faculty who developed and implemented APT that these attitudes can be attributed to a reduction in the frustrations often associated with conventional dental curricula. The decrease in preclinical experiences and the concomitant efforts at earlier and increased clinical exposure have had a major influence in this regard.

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The Effect of Dexamethasone on the Replication of Herpes Simplex Virus in Human Gingival Fibroblast Cultures

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ABSTRACT

Human gingival fibroblast cell cultures, either without added dexamethasone (control) or with dexamethasone were infected with herpes simplex virus and the entire one-step replication cycle of the virus was determined assaying for both intracellular and extracellular virus. Dexamethasone was found to increase the replication rate of the virus and prevent the release of 98–99 percent of the progeny intracellular virus.

INTRODUCTION

Cortisone, hydrocortisone and the synthetic hormones dexamethasone (DXM) and prednisolone are glucocorticoid hormones which possess potent anti-inflammatory properties and have been used clinically to treat a variety of conditions.^{1,2} However, their use is contra-indicated in the treatment of primary and recurrent infections caused by herpes simplex (HSV) and varicella-zoster viruses. Use of these drugs in treating patients with herpetic gingivostomatitis, herpes labialis, herpes progenitalis, herpetic keratoconjunctivitis, eczema herpeticum, herpetic meningoencephalitis or herpes zoster (shingles) have often led to an exacerbation of the infection with disastrous results.^{3,4}

The effect of these hormones on the replication of herpes simplex virus has been studied in a number of cell culture systems. Prednisolone was found to have no effect on virus replication in human skin or corneal fibroblast cells.⁵ Similar results were reported with hydrocortisone in HeLa cells.⁶ DXM, at a final concentration of 10^{-5} M, was shown to reduce total HSV yields in Hep-2 cells;⁷ increase total HSV yields in 3T3 cells;⁸ or reduce the amount of HSV released from infected mouse fibroblast cells.⁸ In most of these studies, the infected cells were assayed for total virus yields only, and at either a 24 or 48 h sampling time after infection. Only Costa, Yee, Troost and Robson⁸ quantitated both intracellular and extracellular virus yields at a single 24 h sampling time.

Based on the results reported in these *in vitro* studies, it would appear that glucocorticoids produce different effects on HSV replication depending on the cell system and hormone studied. However, it is possible that the differences in hormonal effects could be due to the methods used to quantitate the virus samples. The purpose of the study reported here was to determine the effect of DXM on the replication of an oral strain of HSV in a low level passage strain of human gingival fibroblast cells by quantitating viral yields (intracellular, extracellular and total) over the entire one-step replication cycle of the virus, not at single 24 or 48 h sampling times.

MATERIALS AND METHODS

Solutions and Media: The growth medium was Minimum Essential Medium (MEM) with 10 percent newborn calf serum, penicillin (250 U/ml) and streptomycin (100 µg/ml). Plaque medium for virus titrations consisted of MEM, 5 percent newborn calf serum, penicillin (250 U/ml), streptomycin (100 µg/ml) and 0.5 percent methyl cellulose.

Phosphate buffered saline (PBS) consisted of 5.58 g $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$, 5.85 g NaCl and 1.22 g NaOH per liter of double distilled water at a pH of 7.5 Trypsin-Versene (0.025 percent in PBS)

was used to trypsinize the cells.

DXM was dissolved in absolute ethanol and added to the growth medium at a final concentration of 10^{-5} M.

Virus: An oral, type 1 strain of herpes simplex virus, designated HSV-1 KOS was used throughout this study. A large stock pool of virus was prepared in Vero cells and aliquots of the virus were stored at -70°C and used throughout this study.

Cells: Strain 803 is a low level passage strain of human gingival fibroblasts. This strain was originally developed from normal gingival tissue obtained from a patient undergoing surgery for the removal of a partially erupted third molar.

Vero cells are an established cell line of African green monkey kidney cells.

Cells were routinely passed by first washing with PBS and then trypsinizing with a Trypsin-Versene solution in PBS at a pH of 7.5. The cells were then diluted to the desired split ratio and inoculated into 25 cm² or 75 cm² flasks. Growth medium, with or without DXM, was added, the bottles were flushed with 5 percent CO₂, capped and incubated at 37° C.

One-Step Growth Curves of HSV-1 in Human Gingival Fibroblasts: Strain 803 cells were grown to monolayers in a series of 25 cm² flasks. Viable cell counts were made using the Trypan Blue exclusion method. The cells were infected with HSV-1 at a final multiplicity of infection of one. Virus was allowed to adsorb to the cells for 1 h at 37° C with gentle shaking on a rotary shaker. After adsorption, the virus solution was aspirated off and the cells rinsed with PBS. Growth medium (3 ml) was added and the cells incubated at 37° C.

To investigate virus replication, each cell sample was assayed for both intracellular and extracellular virus at various time intervals after infection. To obtain pools of intracellular and extracellular virus, cells from each sampling interval were removed from the flask with a rubber policeman, and the cells and the growth medium were centrifuged for 10 min at 400 g in a refrigerated centrifuge. The resulting supernatant fluids were then frozen and thawed three times (-70°C to 37°C) and served as the extracellular virus pools. The remaining cell pellets were washed, centrifuged and resuspended in 3 ml of growth medium. These cell suspensions were then frozen and thawed three times (70°C to 37°C) to rupture the cells. Cellular debris was pelleted by centrifuging at 950 g for 10 min. The resulting supernatant fluids comprised the intracellular virus pools. Both the intracellular and extracellular pools were stored at -70°C until quantitated.

Identical procedures were used in the studies

designed to determine the effect of DXM on the replication cycle of HSV-1 in the cells, except that the cells were grown in the presence of DXM for 24 h prior to infection with HSV-1 and that the growth medium containing DXM was added to the cells after virus adsorption.

Quantitation of HSV-1 by the Plaque Assay Method: Samples of the intracellular and extracellular virus pools obtained as described above were diluted with PBS in a 10-fold dilution series. A 1 ml aliquot of each dilution was added to a 25 cm² flask of Vero cells, this was performed in triplicate. Virus was allowed to adsorb for 1 h. After adsorption, the virus inoculum was removed, the cells rinsed with PBS and 5-7 ml of plaque medium were added to each flask. The cells were then incubated at 37° C for 3 days and the plaques counted.

The results were recorded as the average number of plaque-forming units per ml (PFU/ml) from the triplicate flasks.

RESULTS

The 803 cells presented a typical fibroblastic type of cell morphology with elongated cells growing in parallel bundles or swirls. The cells were passed at a split ratio of 1:3. At this ratio, they reached a monolayer in 3-4 days.

Preliminary studies were done to determine the optimal DXM concentration and the effect of DXM on cell generation time, cell density and total virus yields. DXM concentrations tested ranged from 10^{-4} to 10^{-9} . The final concentration of DXM selected for use (10^{-5} M) had no effect on the viability, generation time or cell density and produced the maximum difference in total virus yields at 24 h after infection as compared with non-DXM treated 803 cells infected with HSV-1. It was also determined that DXM at this concentration, present in the intracellular and extracellular virus pools of infected DXM-treated 803 cells had no effect on the size, composition or number of plaques produced in Vero cells.

A series of 25 cm² flasks containing monolayers of 803 cells without DXM (controls) were infected with HSV-1. At various time intervals through 48 h, intracellular and extracellular virus pools were prepared as described and the amount of virus in each pool titrated. The experiment was repeated and the results averaged and plotted as seen in Fig. 1. Total virus yields were calculated by adding the average intracellular and extracellular virus titers from both experiments (Fig. 3). The initial decline in extracellular virus through the first 3 h after infection reflected the initial steps in virus attachment, penetration and early replication steps. The 6 h sampling time measured the

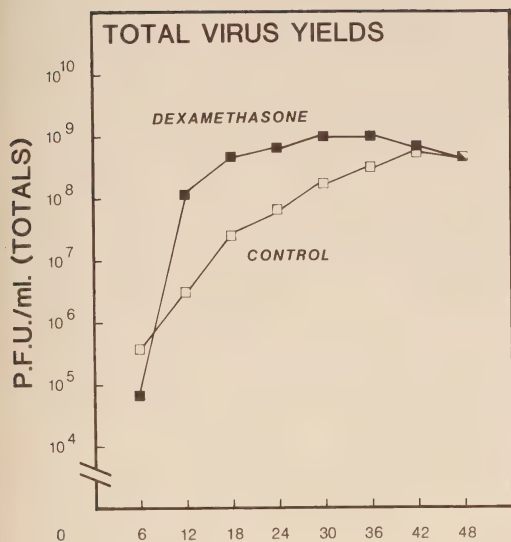


Figure 1: Replication cycle of HSV-1 in 803 cells without DXM (control) assaying for both intracellular and extracellular virus (PFU/ml). Each point is the average of two separate experiments.

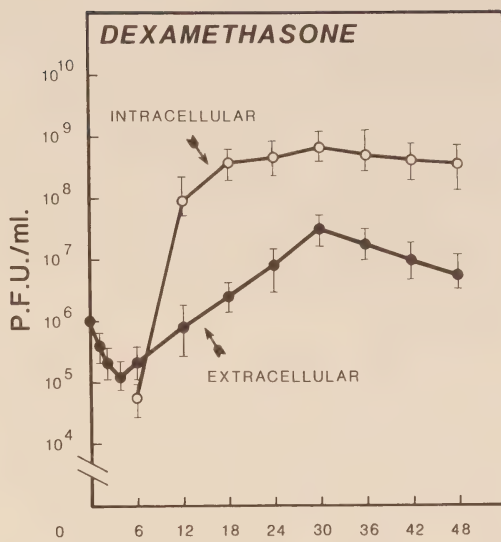


Figure 3: Total virus yields (PFU/ml) calculated by adding intracellular plus extracellular virus yields at each experimental time interval from the data in Fig. 1 (Control) and Fig. 2 (Dexamethasone).

first appearance of progeny intracellular and extracellular virus. Intracellular virus continued to be produced through 30 h after infection. Virus continued to be released from the infected cells throughout the entire 48 h replication cycle. During the entire replication cycle, extracellular virus was always in excess of intracellular virus with final titers at 48 h of 6.0×10^8 PFU/ml and 3.0×10^8 PFU/ml respectively.

To determine the effect of DXM on the replication cycle of HSV-1 in 803 cells, the protocol described above was repeated except that the 803 cells were treated with DXM 24 h prior to infection with HSV-1 and throughout the entire 48 h replication cycle. The experiment was repeated and the results averaged and plotted in Fig. 2. Total virus yields were calculated by adding the average intracellular and extracellular titers from both experiments (Fig. 3). Beginning 6 h after infection (Fig. 2) there was a rapid accumulation of progeny intracellular virus reaching a peak titer at about 18 h with little additional increase through 48 h. Virus was released (extracellular virus) in increasing amounts from the infected cells through 30 h and then amounts leveled off and declined. The most striking difference between the data seen in Fig. 1 and Fig. 2 was the almost complete reversal of the intracellular and extracellular curves between the control and DXM-treated cells. Throughout most of the replication cycle intracellular virus titers were in excess of extracellular virus titers with final titers at 48 h of 5.2×10^8 PFU/ml and 6.2×10^6 PFU/ml respec-

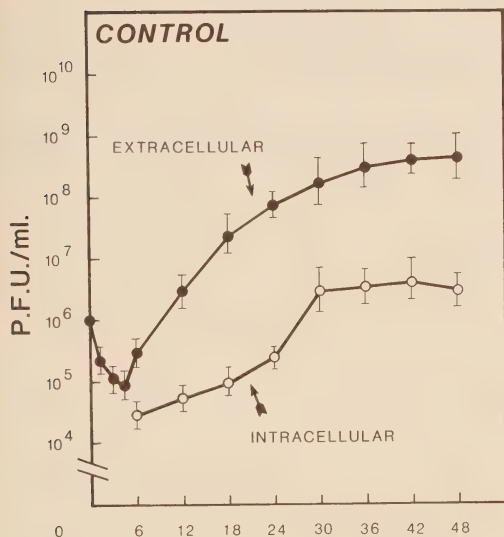


Figure 2: Replication cycle of HSV-1 in 803 cells treated with DXM assaying for both intracellular and extracellular virus (PFU/ml). Each point is the average of two separate experiments.

tively. In the DXM-treated cells, HSV-1 replicated at a much faster rate as measured by the rapid accumulation of intracellular virus between 6 and 30 h after infection as compared with the control cells. Moreover, most of the virus remained cell-associated throughout the 48 h cycle in DXM-treated cells. In spite of these differences made evident by this one-step replication cycle study, total virus yields (Fig. 3) between DXM-treated and control cells were comparable at the end of the 48 h cycle (5.4×10^8 PFU/ml and 5.8×10^8 PFU/ml respectively).

DISCUSSION

The results of this study emphasize the importance of analyzing intracellular, extracellular and total virus yields along the entire replication cycle in order to determine the effect any hormone under investigation may have on the replication of HSV. This is made evident by examining the data at only selected times, 24 and 48 h, in Figs. 1, 2, and 3. Total virus yields (Fig. 3) in both the control and DXM-treated cells were virtually equal at the end of the 48 h cycle. However, total virus yields at 24 h in control cells (7.8×10^7 PFU/ml) and DXM-treated cells (8.0×10^8 PFU/ml) were substantially different. Thus, if this study were done using single sampling times of 24 or 48 h as previously reported,^{5,8} the effects of DXM or HSV replication in 803 cells would have been reported as having no effect if sampled at 48 h or a stimulation of virus production with a 102 percent increase in total virus yields if sampled at 24 h. Assaying for only total virus yields at various times after infection still only reveals part of the real effect of DXM on the replication of HSV-1. A comparison of the intracellular and extracellular virus yields in Figs. 1 and 2 clearly demonstrate that DXM affects the rate of virus replication and more importantly, prevents the release of most of the intracellular virus throughout the 48 h replication cycle. For example, intracellular virus accounted for 98.0 percent of total virus yields in the DXM-treated cells as compared with 0.4 percent in the control cells at 24 h after infection. At 48 h after infection, intracellular virus still accounted for 98.5 percent of total virus yields in the DXM-treated cells as compared with 0.8 percent in the control cells.

The mechanism of hormonal action in this virus-cell system remains to be determined. However, previous investigations have demonstrated cellular receptor proteins for glucocorticoids in several cell systems.^{9,10,11} It is therefore likely that the initial site of DXM/803 cell interaction is also on the cytoplasmic membrane. These DXM-altered membranes may then allow for a more efficient adsorption of HSV-1 to specific receptor sites, which in turn would allow for

a more rapid replication of the virus. Finally, the DXM-altered membranes may also allow for retention of most of the replicated virus by altering the final release step of the virus. These possibilities are currently under investigation.

In summary, the results reported here demonstrated that DXM increases the rate of HSV-1 replication and prevents the release of 98-99 percent of progeny virus from the infected cells. The salient feature of these findings is that these results would not have been observed were it not for a complete one-step replication cycle assay of both intracellular and extracellular virus. The results emphasized the importance of this type of assay procedure in any future studies dealing with possible hormonal effects on virus replication.

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The Teratogenic Effects of Alcohol. A Selected Literature Review.

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ABSTRACT

Historically, excessive use of ethanol has been a significant social problem. It is estimated that there are at least six to eight million alcoholics in the United States, or about 5% of the population.

The effects of alcohol as a drug may be far reaching as endured by the social and physical impairment of the children of alcoholics. That alcohol is potentially harmful to the unborn child has been observed as far back in history as the ancient Greeks and Romans. However, it was not until the development of the new science of teratology in the early 1960's which renewed investigations into the effects of alcohol on fetal development, that led to a "rediscovery" of its actual teratogenic potential. Children born of alcoholic mothers are recognized by a pattern of cranio-facial anomalies, limb defects, developmental delay, and mental retardation, a phenomenon known as the "fetal alcohol syndrome" (FAS) in modern nomenclature. Most babies exhibiting this syndrome are of mothers who demonstrate, in addition to chronic alcoholism, other common characteristics including nutritional anemia, advanced age for pregnancy (28-32 years), and low weight during pregnancy. The study of such a syndrome involves both epidemiological studies and laboratory investigations. The present report reviews the relevant information available in this field.

INTRODUCTION

"The Fetal Alcohol Syndrome" is a pattern of anomalies noted in the offspring of chronic alcoholic women (Jones, Smith, Ulleland, and Streissguth, 1973). This relationship, between maternal alcohol consumption and malformed offsprings, is not a new observation since even the Greeks and Romans believed that conception during the state of intoxication results in birth defects (Green, 1974). Additionally, such birth defects were noted during the "gin epidemic" in England (Warner and Rosett, 1975). Early it was postulated that alcohol caused "blastophthoria" or germ cell damage (Forel, 1893) and anomalies such as imbecility and mental degeneracy (Long, 1879; Gordon, 1911; Robinovitch, 1901).

A. EARLY INVESTIGATIONS.

These studies did illustrate a correlation between parental alcoholism and deformity in offspring, but they did not address the question as to whether genetic defects were transmitted from generation to generation where both parents and offspring were simply more susceptible to alcoholism. A controversial study of alcoholic children suggested just this view by not attributing observed defects in offspring to a condition of alcoholism in the parents but rather to, somatic and psychological patterns leading to alcoholism (Elderton and Pearson, 1910). This report was the first of a small number of studies performed in the early 1900's which proposed a theory of "generalized hereditary damage".

The role of genetics was questioned by Sullivan (1899) who used non-drinkers as control in order to eliminate "neuropathic heredity" as a variable. He found that the children of alcoholic mothers in a prison population had a higher mortality rate than the controls.

B. EARLY ANIMAL STUDIES.

The earliest experimental animal study utilized dogs (Hodges, 1903). Although no strong evidence was obtained, offspring of alcoholic dogs were alleged to have less "vigor and vitality" than those of normal dogs. Pforringer (1912) demonstrated damage to the central nervous system of offspring of alcohol treated mothers. Guinea pigs were treated with alcohol by Stockard (1913) using an inhalation method. Although some deformities were noted, the major effects were low birth weight, high infant mortality and low fertility in the offspring through four subsequent generations, suggesting that alcohol affected the germ cells (Stockard, 1913).

Pearl (1917) treated hens with alcohol vapors to study the effects of alcohol on the chick embryo. He noted a decrease in hatchability but a greater viability was evident in those offspring that did hatch. He interpreted these results to mean that alcohol

exerted a selective action on germ cells, eliminating the less viable ones. Also, using an inhalation method, Nice (1917) found an increase in infant deaths but also a higher fecundity of offspring of treated mice.

Hanson (1928) treated albino rats using an inhalation apparatus similar to Stockard's (1913). Contrary to Stockard, Hanson found that the mean body weight was not lowered by alcohol. He also noted that alcohol depressed the rate of growth, however, this was not passed down to offsprings of the affected individuals (Hanson, 1928).

Alcohol studies performed subsequent to Prohibition was characterized by a strong skepticism and a quasi disregard of earlier literature. Indeed, on the premise that no solid evidence existed, Haggard and Jellinek (1942) absolved alcohol of any teratogenic or hereditary effects. Any correlation that existed was believed to be due to sociological influence and poor maternal nutrition (Haggard and Jellinek, 1942).

In studying the offspring of alcoholics placed in foster homes, Roe (1944) reported that most individuals made proper adjustments to adult life. Commenting on the multitude of reports linking high mortality rates, psychosis, etc. with "physical or chemical germ damage" as a consequence of alcohol intoxicification, Roe (1944) summarized his contemporaries' belief by stating that it simply did not occur.

Chesler, La Belle, and Himwich (1942) injected pregnant rats with varied concentrations of alcohol and then subjected them to a number of experimental conditions in order to determine lethal doses of ethanol. Newborn rats were noted to be the most resistant, while fetal and adult rats exhibited about the same level of resistance. Very few studies of this kind were performed in the years following. In fact, little alcohol related research was performed in the late 40's and 50's and it was not until the mid-50's and early 60's that reports of alcohol related anomalies again reappeared in the literature.

C. HUMAN STUDIES.

Christiaens, Mizon, and Delmarle (1960) demonstrated decreased weight and small stature of offspring of alcoholic mothers. Schaefer (1962) cited a case of a 5 pound Yukon Indian infant exhibiting alcohol withdrawal symptoms. Ullelland (1972) examined 1,594 children born within an 18 month period, 2.9% of whom showed intrauterine growth failure (IUGF). Interestingly, 83% of the retarded growth infants were born to alcoholic mothers. In addition to decreased size most of these infants also exhibited lowered weights and head circumferences smaller than other small-for-date babies.

Subsequently, Jones, et al., (1973) reported that "8 unrelated children of 3 different ethnic groups, all born to mothers who were chronic alcoholics, have a similar pattern of cranio-facial, limb, and cardiovascular defects . . ." There appeared to be a pattern of altered growth and morphogenesis, including craniofacial anomalies such as short palpebral fissures, epicanthal folds, cleft palate, and micrognathia. Additionally, limb anomalies involved congenital hip dislocations, compodactyly, and clinodactyly as well as cardiac anomalies such as atrial septal defects, heart murmurs, and others. Chromosome studies failed to demonstrate abnormalities. This pattern of anomalies, described as the "Fetal Alcohol Syndrome" (FAS) (Jones and Smith, 1973) gave the impetus to the most recent wave of research in this area.

Ferrier, Nicod, and Ferrier (1973) cited an example of a child of an alcoholic mother displaying signs of the FAS in which the chromosomal complement was normal. Hall and Orenstein (1974) linked a genetic disorder, Noonan's Phenotype, with the offspring of a chronic alcoholic woman. In a similar example, Lowry (1977) cites the case of a brother and sister both exhibiting the Klippel-Feil Anomalad. Since the mother was a chronic alcoholic it was suggested that her alcoholic condition may have been responsible for the observed anomalous cervical vertebral segmentation (Lowry, 1977), but no chromosomal damage was detected in either case. Others, such as Palmer, (1975), reported a case of three offsprings of a chronic alcoholic mother displaying features similar to those described in the FAS. Tenbrick and Buchin (1975) also cited similar patterns of anomalies in a child born to an alcoholic mother. An important and neglected study, Lemoine, Haronsseau, Borteyu, and Menuet, (1968), involved 127 offspring of alcoholic parents. All of these, to some degree, exhibited characteristics similar to those described in the FAS. In two further instances of the FAS, it was concluded that "the frequency of adverse outcome in pregnancies of chronically alcoholic women is of such a magnitude that serious consideration should be given toward early termination of pregnancy in such women" (Jones, Smith, Streissguth, and Myrianthopoulos, 1974).

Chromosome studies have been performed in many of the investigations involving the FAS in humans. Although these studies have usually only involved karyotypes, Cadotte, Allard, and Verdy (1973) testing the *in vitro* effects of ethanol on human chromosomes were unable to find significant differences between alcohol containing and control media (Cadotte, Allard, and Verdy, 1973).

D. RECENT ANIMAL STUDIES.

Very few animal experiments were performed in the 1940's and early 1950's until Vincent (1958) experimenting with varying dosages of alcohol administered to pregnant rats, noted that offsprings of treated mothers demonstrated inferior capabilities in mastering novel tasks (Vincent, 1958).

Sandor (1968) injected ethanol into the air chamber of hen eggs of 0 and 23 hours of incubation. Although no specific pattern of anomalies occurred all deformed embryos displayed some type of brain malformation. Injection at 0 hours of incubation resulted in deformed hearts and brain vesicles, abnormal flexure, caudal anomalies, and aberrant somite formation. It was also noted that the malformations could be grouped into the two main classes, those with anomalies in the caudal region and those with brain vesicle malformations, sometimes both types occurring in the same embryo (Sandor, 1968). Histologic examination demonstrated necrosis, possibly resulting from hypoxic conditions due to loss of circulation (Sandor, 1968).

D.1. ORAL ALCOHOL ADMINISTRATION.

Recent investigations were aimed at constructing animal models that reproduce the FAS and/or examine the teratogenicity of alcohol. In one study, 37 female Sprague-Dawley rats were administered 30g ethanol/100 ml H₂O in addition to a balanced powdered diet five weeks prior to mating (Tze and Lee, 1975). The alcohol solution and the diet were administered *ad libitum*, with the alcohol solution as the only fluid source. Subsequent to mating, the pregnant females continued to receive the alcohol solution throughout gestation. The most striking effect noted was the overall decrease in the size of the offspring, but "microcephaly, cracked, dry, loose skin, reddened areas on the head and body, and a generally shrivelled appearance" were also observed in the offspring (Tze and Lee, 1975).

Chernoff (1975) induced a chronic alcoholic condition in two strains of mice, administering alcohol orally by incorporating it into the diet. A mixture of alcohol and a special Metrecal solution composed the diet, where up to 25% of the calories were derived from ethanol. Animals were maintained on separate diets with differing levels of alcohol derived calories prior to mating. Pregnant females, maintained on the alcohol diet throughout gestation, were sacrificed on day 18. Various types of malformations of the offspring were noted, the most common of which was missing or incomplete supraoccipital bones. Rib anomalies and missing sternbrae were also detected in offspring on diets containing a higher level of eth-

anol derived calories. Brain malformations, including small or dilated cerebral ventricles and/or the absence of a corpus callosum, and cardiac anomalies, involving septal defects of the ventricles, were noted even at the lowest alcohol levels. Open eyelids, exencephaly, and gastroschisis were all observed in the higher alcohol levels. Hence, day 18 mouse fetuses displayed a series of anomalies analogous to those noted in children afflicted with the Fetal Alcohol Syndrome.

Offspring of pregnant rats fed alcohol orally in a balanced diet, displayed no physical anomalies except for a decrease in mean litter birth weight. However, pregnancies were permitted to go to term and the presence of dead or resorbed fetuses was not determined. Dissections of offsprings were not performed until 40 days post partum nor were alcohol concentrations quantified (Tittmar, 1977).

Randall, Taylor and Walker (1977) orally administered ethanol diet to pregnant mice from gestation days 5-10. The liquid diet supplied 25% of caloric intake as alcohol. A pair-fed control group was given sucrose as a substitute for alcohol, in addition to a lab chow control group. Limb anomalies included syndactyly, adactyly, and ectodactyly of the forelimbs and occasional distortion of digits of the hind limbs (Randall, Taylor, and Walker, 1977). Aortic branches, vena caval, and interventricular septal defects were some of the cardiac malformations. Urogenital defects of hydronephrosis and hydrourteritis in addition to gastroschisis were seen. Anomalies of the head included exencephaly, hydrocephalus, anophthalmia, and microphthalmia.

Although a very strong correlation between maternal alcoholism and malformed offspring has been recognized since the time of the ancient Romans, alcohol has never been proven as the causative agent. Opposing arguments have attributed malformed offsprings to either genetic effects or the poor nutrition of the alcoholic mother (Haggard and Jellinek, 1942). Both of these conditions have been extensively studied in recent animal experiments.

Methods of teratogenetic testing similar to those outlined by Cook and Fairweather (1968) have been employed by investigators such as Tze and Lee (1975), Chernoff (1975), Randall, Taylor, and Walker (1977), and Kronick (1976). Considerable care was exercised in all of these studies so that alcohol administration was supplemented with adequate nutrition in at least three (3) different species of animals. Additionally, Toews and Lee (1975), who studied the effects of alcohol in adequate nutrition on pregnant rats and their offspring, reported that the mean weight of the offspring decreased significantly but litter size was not affected. In the alcohol study by Tze and Lee

(1975), the decrease of the mean weight of offspring in experimental animals was almost twice that of the nutritional study of Toews and Lee (1975) suggesting that maternal alcohol intake and not nutritional deficiency is the controlling factor in decreasing mean birth weight (Tze and Lee, 1975). Further, lack of adequate nutrition has not been demonstrated to be the causative factor of the patterns of malformations noted in the FAS (Toews and Lee, 1975).

D.2. INTRAPERITONEAL ALCOHOL ADMINISTRATION.

Kronick (1975) administered intraperitoneal injections of 0.03 ml/g body weight of a 25% solution of 95% alcohol in saline to pregnant mice "on one of gestation days 7, 8, 9, 10, 11, and 12". Controls received only the saline injections. Animals treated on days 7, 11, and 12 of gestation did not display a significant level of malformations. The largest number of malformations (60% of live fetuses) occurred when alcohol was administered on day 10 of gestation. The most frequent anomalies were coloboma of the iris and ectrodactyly of the forepaws. These two malformations were apparently time-dependent, occurring in groups injected on days 9 and 10, respectively. Additional malformations observed included hypoplastic atria, hydronephrosis, exencephaly, and others not named.

Beauchemin (1980) noted severe umbilical hernias in offsprings of rats receiving 0.03 ml of 25% alcohol per gram of body weight. Additionally, an interatrial septal defect of the ostium secundum type was noted in 40% of the experimental population.

E. MECHANISMS OF ALCOHOL ACTION.

The mechanism of action of alcohol on the fetus has yet to be elucidated. It has been known for some time that alcohol readily crosses the placental barrier (Chapman and Williams, 1951; Dilts, 1970). Autoradiographic studies have been performed by Akesson (1974) who followed tagged alcohol administered to pregnant mice. Material was shown to pass quickly to the fetus, resulting in high concentrations in the bones and liver. Since alcohol readily dissolves in water and not in fat, the effects of alcohol diffusion are apparently partly influenced by the large total body water of the fetus (Hollstedt, Olsson, and Rydberg, 1977).

Kesaniemi and Sippel (1975) in addition to providing additional information supporting observations that fetal concentrations of alcohol approximate those found in the placenta and maternal circulation, have also reported that acetaldehyde, a metabolic by-product of ethanol, is not as freely permeable as alco-

hol. It was demonstrated that only 25% of the maternal concentrations of acetaldehyde could be found in the placenta and none in whole fetal tissue. It was proposed that this occurs because acetaldehyde is partially oxidized as it crosses the placenta. These findings were independent of the stage length of pregnancy (Kesaniemi and Sippel, 1975).

Full-term placental homogenates, during optimal conditions, were able to oxidize acetaldehyde at a maximum of about 8% of that found in the adult rat liver. Since this rate is five times greater than the calculated rate based on placental blood flow, the placenta can block the entry of acetaldehyde into the fetal blood stream. Additionally, the fetal liver possessed 49% of the adult rat liver activity of acetaldehyde dehydrogenase, indicating that,

"small amounts of acetaldehyde escaping the placental barrier would be rapidly oxidized in the intact fetal liver . . . the small amounts of acetaldehyde that may be formed from ethanol by the alcohol dehydrogenase found in fetal liver near term seems to be eliminated in the liver so rapidly that no acetaldehyde could be detected in the intact fetus" (Sippel and Kesaniemi, 1975).

In the adult, ethanol is metabolized primarily in the cytosol of the liver hepatocyte by the action of alcohol dehydrogenase, which converts ethanol to acetaldehyde, and the MEOS system (Microsomal-Ethanol-Oxidizing-System), of the smooth endoplasmic reticulum. The MEOS is part of mixed-function oxidase system (cytochrome P-450) which oxidizes ethanol and other drugs. Fetal tissues have, reportedly, $\frac{1}{10}$ (150 n mol/ml/g) of the alcohol dehydrogenase actively found in the adult rat under optimal conditions (Raiha, Koskinen, Pikkarainen, 1967). Very little is known about the extent of function of the MEOS system either in the adult or the fetus.

It has been reported that "ribosome-studded" rough endoplasmic reticulum is the sole form found in fetal hepatocytes prior to the third month gestation, at which time development of the "smooth" variety is initiated. This probably accounts, in part, for the general lack of ability of the fetus to metabolize drugs (Rane and Sjoquist, 1972).

The alcohol dehydrogenase reaction requires the presence of NAD^+ as a cofactor, hence during periods of alcohol ingestion much NAD^+ is consumed and converted to NADH. The increased NADH/NAD^+ ratio alters the redox state of the hepatocyte and it is believed that the increased levels of NADH is responsible for much of the pathology evident in alcoholics (Lieber and DeCarli, 1970).

Since high levels of NADH stimulate NADH requiring reactions, such as the conversion of pyruvate to lactate which may spill into the blood causing a hyperlactacidemia (lactic acidosis). Mann, Bhakthavathsalan and Makowski (1975) studied the effects of placental transport of alcohol on fetal and maternal acid-base balance. Initially fetal and later mixed acidoses were observed during the administration of alcohol (Mann, Bhakthavathsalan and Makowski, 1975).

The siphoning of pyruvate for lactate production inhibits gluconeogenesis and a subsequent hypoglycemic state is often encountered (Hollsteadt, Olsson, and Ryberg, 1977). This also implies that less pyruvate may be available for conversion to acetyl CoA and thus a lowered Krebs cycle output. This is not, however, usually experienced as there is an abnormal production of acetyl CoA from metabolism of high levels of acetaldehyde in the mitochondria. Additionally, fatty acid oxidation is inhibited by excess NADH and some of the surplus fatty acids are catabolized to acetyl CoA while others are mobilized to ketone bodies resulting in ketosis (Lieber, 1972).

The remaining fatty acids combine with a glycerophosphate-forming triglycerides which may accumulate in the hepatocytes resulting in fatty liver. Fatty liver change has not been demonstrated to be inducible in rats, although it was in baboons (Lieber, 1972). If these neutral fats are mobilized in the blood, a hyperlipidemia (type IV) may result (Lieber, 1972).

The work of Lieber (1972) helps illustrate the fact that the metabolism of alcohol, even in the normal adult, varies considerably, not only from species to species but also from strain to strain. Indeed, a number of recent studies have demonstrated the variability of ethanol metabolism in the various racial groups of man (Wolff, 1972; Fenna, Mix, Schaefer and Gilbert, 1971).

Although alcohol has not been found to disrupt chromosomal structure (Cadotte, et al 1973), there is evidence of rats fed alcohol during gestation have demonstrated a 30% decrease in incorporation of ^{14}C -Leucine in cerebral ribosomes (Rawat, 1975).

F. BEHAVIORAL EFFECTS OF ALCOHOL.

Probably the most important, yet least studied aspect of the FAS, is the developmental delay and mental retardation reported in almost all cases of children of alcoholic mothers (Jones et al., 1973; Tenbrink and Buchin, 1975; Green, 1974; Ulleland, 1972; Palmer, et al., 1975). These conditions appear to be the most consistent of any symptoms reported in association with the FAS.

Almost no data are available on the behavior

patterns and learning abilities of children exposed to alcohol *in utero*. In addition, very few animal studies address this question at all. In an early study, alcohol was administered to prenatal rats which when tested at maturity "were significantly inferior in learning ability as measured by time, errors, and trials when compared to the controls" (Vincent, 1958).

In a study by Krsiak, Ellis, Poschlova and Masek (1977), moderate levels of alcohol (10% EDC) were administered to pregnant mice in their drinking water. The progeny displayed "increased aggressiveness and locomotor unrest". Further investigation showed that this was associated with "depletion of brain serotonin which was partly due to the alcohol treatment during gestation". Norepinephrine and epinephrine brain concentrations were not found to change. Also, brain weights did not appreciably differ from the controls (Krsiak, et al., 1977).

In contrast, an increase in "number or function" of noradrenergic synapses was reported by Thadani, Lau, Slotkin, and Schanberg (1976) in rats exposed to alcohol *in utero*. It was concluded that,

"maternal ethanol exposure causes postnatal alterations in the development of the central noradrenergic system . . . and these effects of ethanol appear to be unique to the developing nervous system because no such changes were seen in adult rats" (Thadani, et al., 1976).

Other investigators have found evidence of interference with CNS development in animals exposed to alcohol prenatally. Fox, Steinbrechner, Pessel, Inglis, Medvid, and Angel (1978) reported suppression of fetal breathing movements subsequent to alcohol administration to pregnant women, indicating a relationship between fetal CNS activity and breathing. It is important to note that, "the alcohol level achieved . . . was considerably less than any alcohol level associated with the fetal blood gas changes in animal models" (Fox, et al., 1978).

It has also been suggested that there may be potentiation effects of alcohol in combination with other drugs such as caffeine and nicotine, in the production of FAS defects (Streissguth, 1978). Much evidence exists to suggest that frequent exposure to high doses of ethanol *in utero* leads to a variety of gross morphological defects in addition to mental deficiencies (Jones, et al., 1973). Moderate levels of ethanol, when administered *in utero*, have been reported to affect significantly the developing CNS, however, alcohol administered in moderate doses has not been shown to be teratogenic on a gross level (Schwetz, et al., 1978 and Olsund, et al., 1978).

More recent evidence suggests that variations in drinking habits may play a significant role in the production of FAS defects. The effects of "regular" vs. "binge" drinking are not known. Therefore, it appears, that the area of "moderate" alcohol levels, frequently experienced as "social drinking", invites greater attention in terms of potential gross morphological defects in offspring and behavioral aberrations, especially since even a single, high-dose exposure in rats presents a significant threat to normal fetal development. Furthermore, refinement of experimental procedures may demonstrate more subtle consequences of maternal alcoholism.

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Cover Photo: Chest radiograph of crown in the right bronchus intermedius.

Editorial—Aspiration and Ingestion

A recent article in the medical literature presented the case of a 12 year old boy who developed multiple streptococcal lung abscesses a few weeks after orthodontic banding.¹ The authors attribute the pulmonary infections to aspiration of dental cement, and they argue that the supine position increases the risk of aspiration. They conclude their paper as follows:

Physicians should be aware of the risks of the supine position during dental therapy. Patients who are at greatest risk for pulmonary infection (e.g., patients with primary immune defects, sickle cell anemia, cystic fibrosis, neuromuscular-skeletal diseases which compromise cough or gag, etc.) should receive dental care in the upright position when a rubber dam cannot be used.

There are reasons to question the validity of this suggestion. Since adoption of the supine position for dental treatment, there have been millions of dental visits by handicapped persons, and no documentation in the literature of increased problems. Also, the causes for greater risk with the supine position are less convincing than they might initially appear. The most important factor altering size of the pharynx is head position.^{2,3} With the head extended, the pharynx is open, while with the head flexed (chin toward the chest) the pharynx is reduced. During dental treatment, it seems to me that there is more frequent need for a patient to extend the head when in an upright position than when in the supine position. In addition, when supine, the tongue drops back, blocking the pharynx. Pharyngeal dimensions are further reduced when the mouth is open³ (which is always the case during dental work). It is possible that working with supine patients may increase the risk of objects falling toward the back of the mouth, but it may decrease the risk of the object getting past the oro-pharyngeal isthmus.

The aspiration or ingestion of a foreign object is a crisis in the dental office. In addition to pulmonary infections, aspiration may result in death by suffocation. There are approximately three thousand deaths in the United States each year (about 1.6 per 100,000) from blockage of the airway.^{4,5} Although ingestion is usually far less serious, it may lead to esophageal or intestinal perforations or obstruction.⁶⁻⁸

In this issue of the Journal, Drs. Howard Strassler and John Hasler report on two incidents occurring during dental treatment. After their article was accepted for publication, I asked two other members of our faculty to contribute essays on issues that might be of interest to clinicians attempting to respond to a

similar incident in their office. In addition to reviewing methods for avoiding aspiration or ingestion, Dr. Ronald Abrams discusses how the clinician should respond when an object appears to have entered the pharynx; in other words, what to do during the first few seconds. Dr. Stuart Bergman discusses procedures for dealing with the other end of the sequence, when aspiration has resulted in a life-threatening condition in the office.

As a new feature of the Journal, we will publish Letters to the Editor which concern discussion or debate of our articles. The current topic is particularly appropriate. The dental literature on aspiration and ingestion is limited to case reports. We would be particularly interested in hearing from experienced clinicians concerning the frequency of these events. In a busy practice, does it occur once every 20 years or twice a year? Has the frequency appeared to change with adoption of the supine position? Is there an age-group or specific procedure at greater risk? What were the legal consequences? We hope to hear your opinions and facts on these and other issues of concern and interest to all of us.

Richard J. Smith

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Ingestion and Aspiration of Foreign Bodies in Dental Practice: Two Case Reports

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J.F. Hasler, D.D.S., M.S.D.

ABSTRACT

The introduction of any foreign object into the oral cavity can present the risk of either accidental ingestion or inhalation. Two cases of such occurrences are presented. A 37-year-old patient swallowed a full gold crown when the dental student dropped it during try-in. Chest and abdominal radiographs were taken, verifying ingestion. Although the crown was not recovered by the patient, follow-up radiographs revealed its eventual passage. A 57-year-old patient aspirated a porcelain-fused-to-metal undercasting when he coughed during a try-in appointment. Chest films verified that the

foreign object had passed the vocal chords and was lodged in the tracheobronchial tree.

The framework was subsequently recovered through a thoracotomy procedure, which resulted in major complications over an extended postoperative course.

The proper management of these potentially life-threatening incidents is to prevent their occurrence.

Simple procedures are presented to prevent the patient's accidental ingestion or inhalation of any foreign body. Emergency life support measures are discussed should respiratory obstruction occur.

INTRODUCTION

Whenever any foreign object is introduced into the oral cavity during dental treatment, the risk of either ingestion or inhalation of that object, especially when the patient is in a supine position, is a distinct possibility. Continual reinforcement by the dentist of methods to prevent the ingestion or inhalation of any materials placed in the mouth is essential. Emergency measures to employ should such an adverse incident occur must become a routine part of each dentist's office protocol.

Placing the patient in a supine position for dental treatment is now a routine procedure. It permits more efficient practice and greater patient comfort.¹ Few texts or curricula adequately stress the obvious hazard of placing the patient in such a position—the ingestion or inhalation of dental instruments and materials during their manipulation in the oral cavity. In order to place the proper emphasis upon emergency management and prevention, the following cases are presented for discussion.

CASE REPORT 1

A 37-year-old woman, under comprehensive care in a university clinic, reported for a routine restorative appointment. The patient received local anesthesia without any complications preliminary to the try-in of a full gold crown on the left mandibular second permanent molar. During this dental procedure, the student dropped the crown in the back of the mouth and the patient promptly ingested it. The patient was immediately raised to an upright position, but recovery of the crown was impossible. There was no acute discomfort or respiratory distress, and she was informed of the ingestion of the crown. In accordance with standard clinical protocol, the patient was escorted to the university's hospital in order to verify the location of the casting. Physical examination by the attending physician revealed no spasmodic cough. Good breath sounds were present, and inhalations were not obstructed. The preliminary conclusion was that the casting had passed into the esophagus. Frontal and lateral chest radiographs did not reveal the location of the crown. The patient was dismissed and given instructions to examine her stools. Daily telephone contact with the patient over the following two weeks failed to confirm passage of the crown. She denied any history of abdominal pain, cramps, change in bowel habits, constipation, diarrhea or blood in the stool. She reported that although she was thoroughly examining her stools, she had not been able to recover the crown.

After two weeks, the patient was recalled for physical re-

examination by the consulting physician. At this time, she was in no acute distress, the abdominal examination was unremarkable and the stool was negative for occult blood. An abdominal flat plate radiograph revealed the presence of the casting in the ascending colon (Fig. 1). Since the patient was entirely asymptomatic, it was felt that the foreign object would pass in time. The patient was instructed to begin taking a laxative and continue to examine her stools for passage of the casting. She was reappointed for a two-week follow-up examination.



Figure 1: Abdominal flat plate radiograph of crown in ascending colon.

At the follow-up appointment, the patient confirmed that she had consistently examined her stools for the casting and had not yet found it. An abdominal flat plate was taken and revealed that there was no casting in the intestines. Since the radiograph revealed the entire intestinal area, it was determined that the patient had passed her crown and unfortunately did not recover it. No gastrointestinal follow-up was indicated. She returned to the dental clinic for the routine completion of her dental treatment. The length of time which was required before passage of the crown was much greater than that normally experienced in incidents of ingestion.^{2,3}

CASE REPORT 2

A 57-year old man, under comprehensive care in

a university clinic, reported for a routine restorative appointment. No anesthesia was administered and the temporary acrylic resin crown on the right maxillary first premolar was removed to facilitate the try-in of a porcelain-fused-to-metal framework. During this dental procedure, the patient involuntarily coughed, dislodging the casting. Before retrieval was possible, the patient turned his head forward and gagged, ingesting or aspirating the casting. At this time the patient exhibited no signs of airway obstruction or laryngospasm. When it was determined that the patient was in no immediate distress, the oral surgeon on call was contacted. In the emergency room, a chest x-ray and abdominal flat plate radiograph were taken. The radiographs revealed the passage of the casting into the right bronchus intermedius (Fig. 2). The patient was admitted to the Thoracic Surgical Service and preparations were made for endoscopy.



Figure 2: Chest radiograph of crown in the right bronchus intermedius.

Several factors were significant in the patient's past medical history. From 1952 to 1956 the patient was treated for tuberculosis. In 1962, he underwent an appendectomy, and in 1965, a subtotal gastrectomy was performed. In 1971, he was evaluated for possible reactivation of his tuberculosis, although the findings were inconclusive. The patient had a history of alcoholism, but has abstained for the past several

years, taking Antabuse, 250 mg. daily. His only known allergy was to Penicillin.

The chest radiograph indicated, in addition to the metallic foreign body, evidence of bullous emphysema at the right apex. The day after admission, the patient was taken to Endoscopy and a bronchoscopy was performed under local anesthesia. The foreign body was readily visualized in the right lower lobe bronchus, but prolonged attempts, using both fiberoptic and rigid bronchoscopes and a variety of grasping instruments and forceps, were unsuccessful in retrieving the crown. An attempt to retrieve the object with a Fogarty catheter was also unsuccessful. The foreign body was so situated in the bronchus that it presented a smooth superior surface which was difficult to grasp with forceps, and the rough, sharp, angular aspect of it appeared to be embedding itself in the bronchial mucosa.

A chest radiograph on the third day showed the foreign body to have slipped further distally in the right lower lobe. Additional films on subsequent days showed no change in the location of the foreign body, but revealed atelectasis and pneumonitis distal to the foreign body in the right lower lobe. During this period Vibramycin was administered prophylactically. The decision was made to proceed with a limited thoracotomy and bronchotomy.

One week after admission, the patient was taken to the operating room and through a limited right lateral thoracotomy, the chest was explored. The foreign body was firmly wedged in the bronchus and could not be retrieved. Accordingly, the lung was incised at a point where the foreign body lay closest to the surface of the lung. The bronchus containing the foreign body was incised and the foreign body removed. The chest tubes were removed in four days and the chest radiograph revealed relatively clear lungs.

One week post-surgery, the patient abruptly coughed up 300 to 400 cc's of blood, and rales were audible throughout both lungs. Oxygen was administered and the patient was returned to the operating room. A chest radiograph revealed a dense infiltrate in the right lower lobe. An attempt was made to bronchoscope the patient to confirm that the bleeding was coming from the right lower lobe. This was unsuccessful and the decision was made to perform a right thoracotomy. During the thoracotomy, an attempt was made to remove only the posterior basal segment that contained the bleeding pneumonotomy site, but because of technical and anesthetic difficulties the lower lobe was subsequently removed.

The patient's convalescence from this operation was more difficult than from the initial thoracotomy.

During the first five days after the operation, he began to show persistent fever and rales in the left lower lobe. The chest x-ray showed an infiltrate in the lower left lobe. When he did not respond to the Clindamycin, A mikacin was added to the regimen. The fever gradually subsided and the rales and the infiltrate on the chest x-ray gradually cleared. During the postoperative period the patient developed a feeling of numbness in both feet. A neurology consultation was obtained and the etiology of the numbness was suspected to be due to the Antabuse the patient was taking.

The patient was discharged 43 days after admission. The patient's prognosis for resumption of normal activity was good, although it required some weeks for the patient to resume the full range of normal right shoulder and chest wall motion.

DISCUSSION

Whenever any foreign objects are introduced into the oral cavity, care must be taken by the dentist to prevent their ingestion or inhalation. If a foreign object is ingested, in most cases it will pass through the gastrointestinal tract without consequences. In these cases, the foreign object should be monitored by both radiographic examination and the patient's physical examination of the stool to confirm excretion.

All foreign objects passing into the tracheobronchial tree will require prompt removal and present the threat of respiratory obstruction and sudden death. Additionally, the foreign object can induce laryngospasm if it becomes lodged at or near the vocal chords. Should a foreign object become lodged at the tracheobronchial junction, the patient should immediately be uprighted and the tongue pulled forward and down in order to facilitate an open airway. If this crisis is not identified and treated immediately, complete adduction of the vocal chords may occur with subsequent anoxia and cyanosis. The symptoms of partial blockage are a high frequency crowing sound and moderate hypoxia.⁴

The pre-planned emergency alert system should be sounded for this life-threatening incident if there is interruption of respiration. Most authorities feel that slapping a choking person on the back is contraindicated if a foreign body is involved, as this approach may cause the object to lodge further down the respiratory tree. If the tongue thrust fails to obtain immediate signs of recovery, high velocity suction using an open-ended A-tip should be placed in the oropharynx. The action of the suction and the patient's natural gag reflex may assist in recovery. If the object

is located near the vocal chords, recovery by the use of fingers or an instrument is unlikely and may further force it distally. The use of positive pressure oxygen should also be avoided as long as the patient is spontaneously breathing. Should bronchospasm occur, management of the emergency is further complicated by the need to administer appropriate drugs. For many dentists, the patient is now experiencing an emergency that they are ill-prepared to manage.

If the patient has ischemia or arteriosclerotic heart disease, angina and/or dysrhythmia may develop as a result of the hypoxia. Because biological death occurs in four to six minutes, the dentist's next step is to administer a Heimlich Maneuver.⁵ Since it is difficult to perform the frontal abdominal thrust with the patient's back against the dental chair, the patient must be turned sideways in the chair or quickly transferred to the floor. Because dentists are not trained in the use of McGill forceps to recover foreign objects, the patient's life now depends upon establishing an airway by the insertion of a 14-gauge intravenous catheter unit* through the cricothyroid membrane.⁶ After insertion, the nasal mask delivering one hundred per cent oxygen should be connected to establish breathing while awaiting arrival of an emergency medical rescue unit which will transport the patient for follow-up treatment. After establishing an airway, the pulse must be monitored to ensure that standard cardiopulmonary resuscitation is not indicated. Mucus secretions may be cleared using high-velocity suction.

From the foregoing, it may readily be seen that the ingestion or inhalation of foreign objects in the oral cavity is both an unnecessary and potentially life-threatening consequence of dental procedures. Definitive measures of prevention must be practiced in order to prevent this occurrence. Such an incident can and does occur all too frequently in the dental office. It can be both embarrassing and costly, and can subject the patient to inconveniences, anxiety, and discomfort. The management of a life-threatening obstruction by depending upon rescue medical personnel is not feasible because of the four to six minute response time necessary to prevent death. Preventive measures in addition to thorough CPR training are, therefore, mandatory.

There are several methods of preventing the ingestion or inhalation of foreign objects into the oral cavity. Whenever possible, placement of the rubber dam in the arch being treated will shield the throat from all foreign objects.^{7,8} Care must be taken during

the manipulation of the rubber dam clamp to avoid its ingestion or inhalation. There have been two case reports of incidents with rubber dam clamps; in one case the clamp was swallowed by the patient and lodged in the esophagus where recovery was performed by esophagoscopy.² In the other case, the rubber dam clamp lodged in the nasal cavity and required general anesthesia for removal.⁹ Ligating dental floss to the clamp (Fig. 3) will help avoid these consequences. Care must also be taken when performing endodontic procedures and placing amalgam retention pins using hand wrenches (Fig. 3).¹⁰ Ingestion of endodontic instruments has been reported in the literature.³



Figure 3: Use of dental floss ligature around pin wrench and rubber dam clamp to permit retrieval if dropped in oral cavity.

When placement of the rubber dam is not possible, the use of a gauze shield in the posterior throat region is an acceptable alternative (Fig. 4). This is especially indicated when using pin wrenches without the rubber dam, when seating castings, and when performing oral surgery. With the patient in the

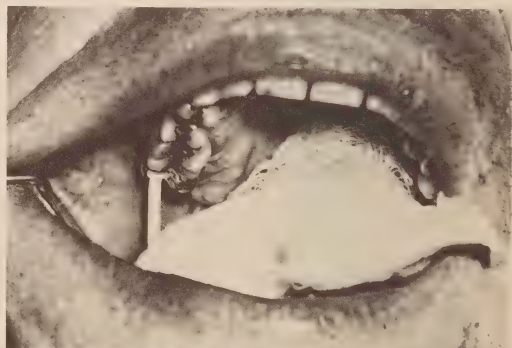


Figure 4: Gauze throat pack in place during the insertion of full crown casting on maxillary second molar. Note the use of a cotton applicator stick to hold the seated casting in place while verifying margins.

* Monojet 410 Emergency Tracheal Catheter, Sherwood Medical Industries, Deland, Florida 32720

supine position, it is important to position the head so that any object dropped will fall toward the cheek and vestibule on the side being treated. During dental treatment, additional risk is also placed upon the patient when removing existing restorations or when an instrument breaks within the mouth. In the latter incident, it is important to retain all pieces of the broken instrument to permit re-assembly of the broken parts at recovery to insure that no portion remains missing.

SUMMARY

Ingestion or inhalation of foreign objects has been reported in the literature.^{2,3,9} Two adverse incidents involving the ingestion and the aspiration of dental castings are reported. For one patient who ingested a casting, no life-threatening consequences occurred, although the patient was considerably inconvenienced for almost one month before resolution of the incident. For the other patient who aspirated a casting, significant complications developed. Techniques to manage the emergency and/or prevent the ingestion or inhalation of foreign objects are presented. Prevention remains the best approach in all cases. These techniques must be utilized to protect the dental patient.

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The Prevention and Management of Foreign Object Accidents in Dentistry

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ABSTRACT

With patients treated in the supine position, dental objects can fall into the oropharynx and be ingested or aspirated. Measures are presented to prevent intraoral accidents and appropriate actions in various emergency situations are suggested.

INTRODUCTION

Many aspects of health care possess inherent risks. For the practicing dentist, there is considerable potential for mishaps while providing surgical, restorative, prosthetic and even preventive treatment. Although relatively few incidents have been reported in the literature,¹⁻⁵ most practitioners are aware of personal and colleague minor accidents and "close calls". How often do burs break, bands or crowns fall onto the back of the tongue, and fragments of restorative material disappear without serious effect? In most cases, the patient's natural protective mechanisms and rapid response by the dentist and assistant frequently interrupt an acute crisis.⁶ Foreign objects are coughed up and/or are quickly retrieved. The incident is casually dismissed and treatment is continued.

In reality, life-threatening catastrophes can occur. Foreign objects can be swallowed, pass through the digestive system, and in 1-3 days be recovered in the stools. On the other hand, complications can result in G.I. blockage, abscess, perforation and peritonitis.⁷ The major concern of an oral accident is aspiration of an object causing airway obstruction. Dental materials can lodge in the larynx producing partial or complete obstruction, or be aspirated into the trachea and bronchus causing infection, lung abscess, pneumonia and atelectasis.⁷

Further concern has been expressed with the relatively recent emphasis on four handed dentistry.⁶⁻¹⁰ In this delivery system, the supine position of the patient enhances the effect of gravity, and a dropped object will naturally fall into the posterior portion of the oral cavity. It is also important to recognize that in the supine position, the patient's tongue drops back into the oropharynx and frequently establishes a mechanical barrier. In contact with the pharyngeal wall, the tongue can seriously interfere with air exchange, and is recognized as the most common cause of airway obstruction.¹¹

In contrast to an erect patient, an accident in the horizontally positioned patient paradoxically may be easier to correct. Access and visibility in the oral cavity is better and the body's position is more amenable to initial treatment of airway obstruction. Later in this discussion, it will be described how the dental team can take advantage of the tongue's position and recover a foreign object. With an appreciation of the advantages and disadvantages of treating a supine patient, the dental team should routinely take precautions and be prepared to respond quickly to an emergency.

The purpose of this paper is to describe measures for preventing ingestion or aspiration of foreign objects, and management of accidents in the supine or semisupine patient.

PREVENTION OF ACCIDENTS

Rubber dam isolation has clear advantages in the practice of four-handed dentistry. It permits better access and visibility of the field of operation, controls saliva and tongue movement and retracts soft tissues. It, additionally, acts as a mechanical barrier protecting the oropharynx. Ultimately, the rubber dam contributes to increased efficiency, patient comfort and safety.¹² Unfortunately most dentists do not routinely employ the technique, although a recent (1978) survey in Kentucky demonstrated that recent graduates utilize rubber dam more frequently.¹³

Although rubber dam provides optimal protection for the patient, certain precautions are advised. Rubber dam clamps can break or slip off the tooth, and one case of a child ingesting a clamp has been reported.¹ For this reason, the following suggestions are offered.

1. *Selecting the proper clamp.* Clamps should fit tightly and not be dislodged digitally. The tines of the clamp should be sharp and contact the tooth surface. Clamps that are large, oversprung or with dull tines may rotate on the tooth or slip off easily when tension is applied to the rubber dam. Partially erupted teeth, of course, require deep reaching clamps.
2. *Seat the clamp completely.* Apically directed pressure will assure the clamp is seated at the C-E junction. To test adequate seating and fit, position a finger under a clamp wing and attempt to dislodge occlusally.
3. *Ligate the clamp.* Clamps with dental floss tied on the bow can be retrieved more easily. The assistant can hold the floss while the operator is seating the clamp. Because clamps can break if work-hardened or opened excessively, some authors recommend a special tying technique to secure the clamp.² The floss is attached in the lingual hole, looped around the bow, and then attached to the facial hole.
4. *Engage the clamp in the rubber dam before placement.* Other dam techniques which pose less risk involve securing the clamp wings in the rubber dam before placement. This is accomplished with or without the dam on the frame. In this way, the attached clamp is attached to the dam and more easily retrieved should it dislodge. Caution is still needed since rubber dams tear, and clamps may slip off the dam, therefore, ligating the clamp with floss is still advised.

Alternative techniques are available to the dentist who elects not to use rubber dam isolation. Although less safe, these techniques and devices will reduce the danger of ingestion or aspiration.

Dentists commonly employ an oral gauze pack to prevent dental materials, debris, teeth, blood and

saliva from passing into the pharynx. Often a 2 × 2 gauze is opened and positioned distal to the operating field. This protective screen is recommended particularly for inserting and removing bands and crowns and extracting teeth.

Numerous saliva ejectors and mouth props are helpful, though less optimal substitutes for rubber dam. They provide some control of tongue and jaw movement, and better visibility and accessibility. The rubber bite block and especially the scissors type molt prop may aid in maintaining the mouth open while retrieving a lost object. The Dryfield mouth prop is particularly useful when treating anterior teeth. Its plastic body acts both as a prop and a protective shield. The sphedopter, hygroformic and Erickson saliva ejectors help control the tongue and minimize oral fluids in the operating field. The design of the Erickson also includes a rubber shield which prevents objects from passing to the posterior portion of the mouth.

Proper utilization of high speed evacuation can help avert accidents. The broad opening of the tip should be maintained parallel and close to the tooth or region being treated to provide maximum suction efficiency. Although not always possible, lingual placement of the evacuator provides the most safety. In this way tooth fragments, soft tissue pieces and dental materials can be removed from the mouth.

When seating or removing temporary, stainless steel or cast crowns, the operator should secure the restoration with both hands, always maintaining one digit on the occlusal surface. These small objects can easily slip especially when in contact with saliva, or fall when a patient unpredictably coughs, sneezes or gags. Bands should be seated similarly, and a band remover used for removal. When checking the proximal contact of cast crowns with dental floss or tape, be aware that the crown can dislodge. Generally, it is not possible to try in crowns and check fit and occlusion with rubber dam or other protective devices. To counteract gravity, it is suggested that the head be turned right or left. In this way, a lost object would tend to fall buccally rather than towards the oropharynx.

Frequently burs become loose or break. Friction grip burs should be snugly engaged in the chuck and latch types burs correctly secured. Special attention should be given to long tapered burs which tend to break easily. Similar caution is advised when inserting and adjusting retention pins.

Patients who are deeply sedated with premedication may experience a diminished gag reflex. Lacking a fully functioning protective mechanism, the patient is more susceptible to ingestion and aspiration acci-

dents. A bilateral mandibular block can also reduce the patient's sensitivity to foreign objects.

Even detachable rubber cups from prophylaxis angles and the brushes of sealant applicators have fallen into the mouth, fortunately without serious sequelae.

The intention of this section of the discussion is to sensitize the reader to various precautions and suggestions for minimizing foreign object accidents. The subsequent part will focus on the appropriate responses of the dental team in different accident scenarios. It will be assumed that sit-down, four-handed dentistry with the patient will be applied to the management of various emergencies. The author will also assume that the reader is familiar with cardiopulmonary resuscitation principles and techniques.

MANAGEMENT OF FOREIGN OBJECT ACCIDENTS

Scenario #1

An object drops on to the back of the tongue, is often visible, and the patient is not gagging.

In a calm, casual voice, ask the patient to keep the head still and mouth open. Do *not* change the patient or chair position. The repositioned tongue usually will keep the object out of the oropharynx. The operator or assistant can then remove the object digitally with pickup forceps or suction.

Scenario #2

An object drops back into the oropharynx and the patient obviously "swallows" it with or without gagging and coughing.

Although the patient is not in distress and no object is recovered, it can *not* be presumed that the object has entered the esophagus. A small object can pass into the trachea without dramatic signs or symptoms. The patient should be referred immediately for medical consultation and radiographs.

Scenario #3

An object drops back into the oropharynx and the patient exhibits signs of partial air obstruction with good air exchange, (i.e., coughing or gagging, with or without intermittent wheezing, and normal skin, mucous membrane and nail bed color).

Turn the patient's head to the side or over. If not already done so, the chair back should be moved into a feet up, head down position. Both these maneuvers will allow gravity to assist in the recovery. Encourage the patient to continue coughing until the object is expelled. *As long as the patient is coughing and breathing, do not interfere.* If the patient begins to exhibit signs of poor air exchange or complete obstruction, treat as described in Scenario #4 or #5.

Scenario #4

The object falls into the oropharynx and the patient exhibits evidence of *partial airway obstruction with poor air exchange* (i.e., weak, ineffective cough, high-pitched "crowing" sound on inhalation, increased respiratory difficulty, ashen-gray color of skin, possible cyanosis of nail beds and mucous membrane).⁷ Essentially partial obstruction with poor air exchange and complete obstruction are similarly managed.

Ask patient if he can speak, to differentiate from a possible cardiac emergency. Place patient in feet up, head down position and turn on side (Trendelenberg). Encourage coughing, but if no improvement, give four quick back blows between the shoulder blades. Then apply four abdominal thrusts, except for pregnant women and obese patients for whom chest thrusts are substituted. Employ a finger sweep of oral cavity (also can use suction). Repeat back and manual thrusts (four each).

If the patient stops coughing, and indicates that the object is swallowed or aspirated, (i.e., not recovered), the patient should have an emergency evaluation by a physician. Even if the foreign object is retrieved, the patient should be examined for residual tissue trauma. Partial airway obstruction can proceed to complete obstruction.

Scenario #5

The object falls into the oropharynx and the patient exhibits signs and symptoms of *complete airway obstruction* (i.e., with great difficulty trying to breathe, little or no noise (crowing), suprasternal retraction, grabbing throat, can not speak).¹¹

Treat same as patient with partial obstruction with poor air exchange. *If the patient loses consciousness, call for help* (i.e., an advance life support unit, such as the fire department or the local emergency medical services), and attempt to ventilate the patient. Administer back blows, manual thrusts and finger sweeps, and again attempt to ventilate. (Repeat until help arrives.) If it is not possible to reestablish an airway, a surgical opening must be made (i.e., tracheotomy, cricothyrotomy) and oxygen administered. This is a last resort procedure "that should be carried out only by persons proficient in the technique."¹¹

Scenario #6

The patient is found unconscious and the etiology is unknown.

If the patient is unresponsive, call for help, and open the airway by extending the head and neck and digitally thrusting the mandible downward and forward. These maneuvers in a supine patient will move the tongue out of the pharynx. With no evidence of breathing, attempt to ventilate. If unsuccessful, pro-

ceed to treat as the patient with complete airway obstruction.

SPECIAL CONSIDERATIONS FOR INFANTS AND CHILDREN

Infants (0-1 year) The patient experiences complete or partial airway obstruction with poor air exchange.

Holding the infant face down on your forearm with the head lower than the trunk and supporting the head with your hand, apply four quick back blows. Turn child over and place on your thigh and apply four chest thrusts (use two fingers on midsternum). Apply a fingersweep only if the foreign object is visualized. A blind fingersweep may drive the object farther back. If unproductive, reposition the infant's airway and attempt to ventilate. If unsuccessful, repeat above procedure in rapid sequence until the object is expelled, unconsciousness occurs, or help arrives.

Children (1-8 years) The patient experiences complete or partial airway obstruction with poor air exchange.

Drape child across your thighs, with the head lower than the trunk. Apply four back blows. Roll child over onto chair or floor and apply adult type chest thrusts (heel of hand on lower half of sternum). After applying a finger sweep, reposition and attempt to ventilate. Repeat previous steps if necessary until the object is expelled, the child becomes unconscious or help arrives.

SUMMARY

Dental objects are frequently dropped or "lost" in the oral cavity. In most instances, serious sequelae are avoided by the patient's natural protective mechanisms and quick action by the dental team. Measures are presented to prevent intraoral accidents and suggestions are discussed to help the dentist and chair-side assistant respond appropriately in various emergency situations. The dental team is encouraged to review emergency procedures regularly to assure prompt recognition and intervention.

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Management of Upper Airway Obstruction

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ABSTRACT

Complete obstruction of the airway becomes life-threatening within 4-6 minutes. When all non-invasive measures to remove the obstruction have failed, emergency cricothyrotomy may save a patient's life. The method for performing this procedure is reviewed.

INTRODUCTION

Suffocation due to airway obstruction can become life-threatening within 4-6 minutes. The dentist faced with this emergency must be prepared to take immediate action. There are several procedures available for establishing an emergency airway. Two of these are invasive, tracheotomy and cricothyrotomy, and require surgical intervention. The others, such as the abdominal thrust maneuver (Heimlich Maneuver) accompanied by back blows are non-surgical and non-invasive. Consequently, whenever the basic life support techniques of head extension and jaw thrust prove inadequate, the abdominal thrust maneuver should be attempted several times before either of the surgical procedures is performed.

Of the two surgical procedures available the cricothyrotomy is presently considered by many authorities as the procedure of choice.¹⁻³ The tracheotomy is not well-suited as a method to establish an emergency airway. The tracheotomy site contains numerous anatomic structures such as the isthmus of the thyroid gland and several large blood vessels inferior (the innominate vessels) and lateral (the common carotids, internal and anterior jugular veins) to the surgical field, which if lacerated can rapidly lead to exsanguination of the victim⁴ (Figures 1 and 2). In addition, the esophagus lies directly behind the airway. Perforation is not uncommon as a complication of tracheotomy. The recurrent laryngeal nerves lie in a groove between the esophagus and the trachea. These nerves may be damaged resulting in partial or complete paralyses of the vocal cords. Finally, the cupula of the lungs often extend into the base of the neck; laceration of the pleura with creation of a pneumothorax has also been reported. Cricothyrotomy is a much simpler surgical procedure than tracheotomy, and is, therefore, associated with a much lower incidence of complications. Anatomically, no significant structure overlies the cricothyroid membrane (Figure 3). Occasionally, the left and right cricothyroid arteries have horizontal anastomosis across the upper border of the cricothyroid membrane. The pyramidal lobe of the thyroid gland is rarely present and then usually to the left of the midline. Consequently, the incision, made through only skin, subcutaneous adipose tissue, and fascia is below or to the right of these anatomic structures. Bleeding, therefore, is seldom encountered. Inadvertent perforation of the esophagus is prevented by the complete posterior cartilaginous ring of the cricoid cartilage.

ANATOMY

It is essential during an emergency to rapidly locate the proper site for the cricothyrotomy. The thyroid cartilage and the cricoid cartilage represent the anatomic landmarks for the cricothyrotomy. A membranous structure, the cricothyroid membrane forms the soft tissue connection between the lower border of thyroid cartilage and the superior border of the cricoid cartilage at the anterior midline. It may be readily located by placing a finger on the thyroid

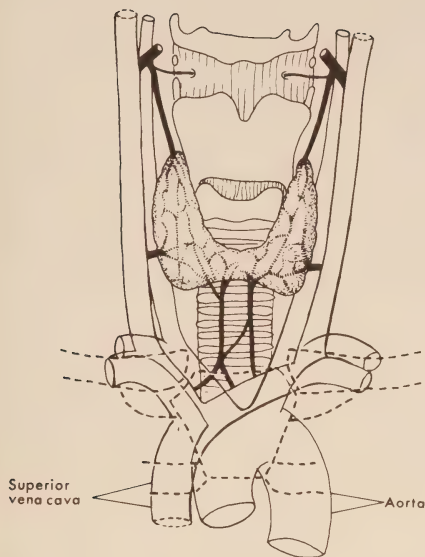


Fig. 1: Frontal view showing close anatomical relationship of the great vessels of the neck and upper thorax with the larynx and trachea.



Fig. 2: Sagittal view showing the recurrent laryngeal nerve in the groove between the esophagus and trachea, and the relationship of major arteries.

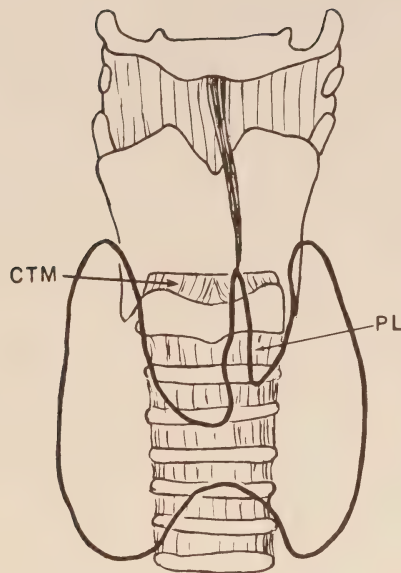


Fig. 3: The pyramidal lobe of the thyroid gland (PL) sometimes comes across the cricothyroid membrane (CTM), but usually is to the left of the midline.

prominence (Adam's Apple) and moving the finger inferiorly until a slight depression just superior to the cricoid cartilage (1st tracheal ring). This is the cricothyroid membrane.

TECHNIQUE

Place the unconscious patient supine and extend the head to permit easy identification of the thyroid and cricoid cartilages and the cricothyroid membrane. Holding the thyroid cartilage between the thumb and second finger the index finger identifies the cricothyroid membrane. Using a scalpel with #15 blade, an incision is made approximately 2 cm in length across the anatomical midline perpendicular to the long axis of the trachea through the cricothyroid membrane until the lumen of the trachea is entered. Anesthesia is not needed. The cricothyroid membrane is elastic tissue and will often pull open. The patency of the opening is assured, however, by placing the handle of the scalpel into the wound and rotating it toward the vertical position.

Often once a patent airway is established spontaneous respiratory movements resume or become effective. The patient will rapidly regain consciousness. If spontaneous respirations do not resume artificial ventilation must be provided mouth to stoma

or some other positive pressure technique. The carotid pulse should then be palpated to assure circulation. If no pulse is palpated CPR is begun.

In order for the cricothyrotomy to be successful the stoma must be made distal to the airway obstruction. In the adult airway the narrowest portion is located in the larynx just above the true vocal cords (Figure 4). Most objects that produce obstruction come to rest in this area. The cricothyroid membrane is below the true vocal cords, therefore, distal to the obstruction.

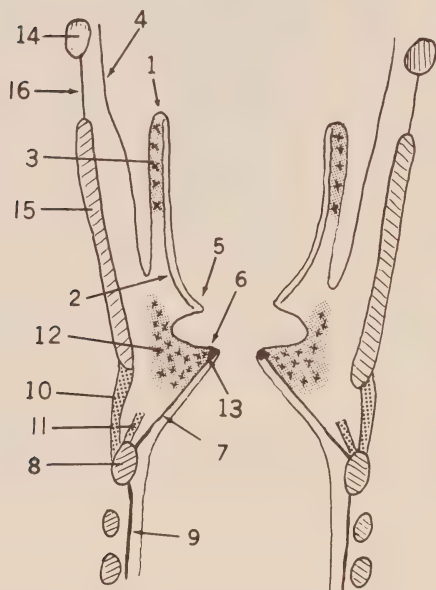


Fig.4: Narrowest portion of adult laryngeal airway is located just above the true vocal cords (6). Identified are the aryepiglottic fold (1), each with its quadrangular membrane (2) and aryepiglottic muscle (3), mucous membrane (4), the vestibular folds (5), conus elasticus (7), arch of the cricoid (8), elastic lamina (9) of the trachea. Also illustrated are the cricothyroid muscle (10), lateral cricoarytenoid muscle (11), the thyroarytenoid muscle (12), and vocalis muscle (13) thyroid cartilage (15) and thyrohyoid membrane (16).

In children under ten years of age the narrowest portion of the airway occurs below the true vocal cords.⁵ As in the adult, obstruction is most likely to occur at this point. Since the cricothyroid membrane is at or just below the vocal cords a cricothyrotomy is often ineffectual. In these children a tracheotomy is necessary to create a stoma distal to the point of obstruction. As suggested above, emergency tracheo-

tomy is difficult to perform even under ideal conditions in experienced hands, therefore, I do not recommend this procedure. In these children one should repeat the non-invasive procedures again and again in the hope that one of these maneuvers will be successful.

Objects that are small enough to pass through the larynx and enter the trachea normally pass into one of the mainstem bronchi, usually the right (Figure 3). Total or partial obstruction of one lung, although an emergency, is not immediately life threatening. The patient can usually be transferred to a hospital for definitive care.

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Immunologic Studies of Endodontic Disease: Measurement by the ELISA Technique of Antibody Reactive with *Fusobacterium nucleatum* in the Serum of Endodontic Patients

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ABSTRACT

Serum (IgG) antibodies reactive with oral strains of *Fusobacterium nucleatum* were measured by an enzyme-linked immunosorbent assay, ELISA.

Serum IgG levels were observed in patients with pulpal infections. Antibody levels in these patients were not significantly different from those of control patients. In addition, no significant differences were observed between the antibody levels in the serum of the patients at the time of canal obturation and in a sample taken two weeks after therapy was completed. The significance of antibody in serum reactive to *F. nucleatum*, and its role in protection or immunopathology in pulpal tissues is discussed.

INTRODUCTION

Since anaerobic bacteria have been isolated from pulpal infections¹⁻⁴ the presence of serum antibody reactive with antigens of these bacteria might induce in the host a protective or immunopathologic response in pulpal and/or contiguous periapical tissues.² In the past, pulpal infections were cultured for bacteria using an aerobic environment, virtually eliminating the possibility of isolating anaerobic microorganisms present within the root canal system.⁵⁻⁷ Within the past five years, techniques for the isolation and culturing of anaerobes have improved, and the results of the recent studies have shown an increased isolation of anaerobes from these infections.¹⁻⁴ Although both gram positive and gram negative anaerobes are present and may be active in the disease processes in human pulpal infections, very little research has been reported regarding a specific biological relationship of these organisms to the host.

The latest studies suggest that members of the genus *Fusobacterium* are major isolates from root canals of teeth with intact pulp chamber walls and necrotic pulp tissues.⁸⁻¹⁰ *Fusobacterium* are indigenous organisms of the human oral cavity and are major pathogens in anaerobic infections of the oropharynx.¹¹ *Fusobacteria* have been observed to increase in number in bacterial plaque and inflamed gingival crevices as untreated periodontal diseases progress.¹²⁻¹⁴ Sabiston and Grigsby¹⁵ and Crawford, Socransky and Bratthall¹⁶ reported large numbers of *Fusobacteria* isolated from plaque taken from periodontal pockets. Palenstein-Helderman¹⁷ reported that *Vibrio sputorum* and *F. nucleatum* accounted for more than 80% of the cultured gram negative anaerobes associated with inflamed gingival pockets. *Fusobacterium* species, in particular *F. nucleatum*, have been frequently isolated from pulpal infections.^{1,2,9-11}

The root canal has been proposed as a mode of sensitization of the immune system. Rosengren¹⁸ reported a significant antibody response to -hemolytic streptococci placed in the pulp space of cats, especially if the adjacent periapical area was inoculated with the organism. Barnes and Langeland¹⁹ placed bovine serum albumin in the pulp space of monkeys and then demonstrated the presence of serum antibodies reactive with albumin. The pulp space of the dog is a potential pathway for sensitization to various commonly used dental materials and medicaments.^{20,21} Lippolysaccharide preparations of oral *F. nucleatum* strains when placed in the pulp chamber stimulated an immune response both in the lymph nodes and the spleen resulting in circulating antibodies.²²

The presence of immunoglobulins in the periapical region has also been reported. Using immunoelectrophoresis, Naidorf²³ demonstrated the presence of immunoglobulins in periapical granulomas. Kuntz and Genco²⁴ found immunoglobulins as well as components of the complement system in periapical lesions. Morse, Lasater and White²⁵ reported the presence of immunoglobulin-producing cells in periapical cysts and granulomas. Kreutzer et al.²⁶ suggested a relationship between the incidence of reactive antibody from patients with pulpal infection and *B. gingivalis* by using an indirect fluorescent antibody technique.

The purpose of this study was to determine by means of an enzyme linked immunosorbent assay (ELISA) if individuals with pulpal infections displayed antibody in their serum reactive to oral strains of *F. nucleatum* and to compare the levels of antibody present with serum from individuals without any prior pulpal infection.

MATERIALS AND METHODS

SELECTION OF PATIENTS

Patients were selected from the clinic of the University of Maryland Dental School. The medical and dental history of the patient and the history of the tooth in question and its present clinical signs and symptoms were recorded (Table 1). Nine patients were selected for the experimental group presenting with a single rooted tooth with intact pulp chambers, a radiographic discernable periradicular rarefaction and no other obviously diseased pulps or previous endodontic treatment. A control group of eight patients had no previous history of endodontic treatment, pulp capping, or avulsions.

Clinical diagnostic tests were performed on each of the diseased teeth at the initial appointment (Table 2). Ten ml of blood were collected from the median cubital veins of the patients in the experimental group at this first appointment. The tooth (or teeth) treated was isolated with a rubber dam, pumiced, rinsed, and disinfected by betadine followed by 70% ethyl alcohol. Access was gained with sterile burs and a sample was taken from the canal with a sterile paper point and placed in reduced transport fluid. After dispersion of the sample, gram stains were prepared.

Root canal therapy was initiated after collection of blood and bacterial samples. Each tooth was treated according to normal treatment protocol and obturated by a lateral condensation technique with gutta percha and AH-26 sealer. Two weeks after completion of root canal therapy, an additional ten ml of blood were drawn. The prepared sera were stored at -20°C until

used in the ELISA testing procedures.

CULTURES AND CULTURAL CONDITIONS

Two strains of *Fusobacterium* were used in these studies: ATCC 10953 and 10197. All strains were tested upon acquisition for purity of culture by subculturing on blood agar plates and phase microscopy. Organisms were grown in a modified tryptone medium containing 1% tryptone (Difco), 1% yeast extract (Difco), 0.2% dextrose, 0.5% thioglycollate, 0.125% K_2PO_4 , and 0.125% $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, using the BBL anaerobe jar-Gas pak system. After 18 to 24 h of growth, the organisms were harvested by centrifugation at $10,000 \times g$ for 10 min and washed three times with 0.15 M NaCl. The organisms were routinely resuspended in 0.01 M phosphate buffer containing 0.15 M NaCl and 0.2% sodium azide (PBS) at a concentration of approximately 0.25 g/ml or in a 10% suspension (packed volume, after centrifugation at $800 \times g$ for 15 min, diluted 1:10 in PBS).

MICRO-ENZYME-LINKED IMMUNOSORBENT ASSAY

This was a modification of the method described by Poxton.²⁷ Briefly, 200 μl of a 1% *F. nucleatum* whole cell suspension in 0.06 M carbonate buffer, pH 9.6, were added to each well of a microtiter multi-well plate* (outside rows of wells not used) and incubated at 37°C for 3 h followed by refrigeration overnight. The plate was washed three times with PBS containing 0.05% Tween 20 and 1% BSA. Then 200 μl of a 1% BSA solution in 0.06 M carbonate buffer, pH 9.6, were added to the wells and incubation allowed to proceed for 3 h at 37°C in order to tie up all non-antigen coated binding sites. The tray was then rinsed five times with PBS/Tween 20 with 1% BSA. Serial two fold dilutions of the sera (50 μl) in PBS were added to each well and the plates incubated at 37°C for 30 min. The plates were washed as before and *F. nucleatum* absorbed peroxidase labeled IgG fraction of goat anti-human γ , μ or α heavy chain or globulin serum (Miles Laboratories) diluted 1:500 in PBS, was added to each well (50 μl) and incubated for 1.5 h at room temperature. After again washing the plates, 50 μl of the enzyme substrate (1 ml of 1% w/v O-phenylene-diamine in methanol + 99 ml distilled H_2O + 0.1 ml 3% H_2O_2) were added. After 1.5 h of incubation in darkness at room temperature the reaction was stopped by the addition of 8 N H_2SO_4 (25 μl) and the color was read visually on a ++++ - scale. The end point of the titration was judged as ++, that is, when the intense color had just started to decrease.

* Dynatech Laboratories, Inc., Alexandria, Virginia

TABLE 1
Patient History and Clinical Observations

| <i>Patient #</i> | <i>Age</i> | <i>Clinical Appearance</i> | <i>Radiographic Evidence of Periapical Pathology</i> | <i>Perio. Condition</i> | <i>Chief Complaint</i> |
|------------------|------------|--|--|-----------------------------|--|
| 2 | 27 | Tooth #9. No history of trauma. No restorations. | + | Negative | Asymptomatic |
| 3 | 39 | Tooth #23. No history of trauma. No restorations. | + | Negative | Asymptomatic |
| 4 | 18 | Tooth #8. CI II fracture of incisal edge. No restorations. | + | Negative | Asymptomatic |
| 5 | 16 | Tooth #8. CI II fracture of incisal edge. No restorations. Tooth #9. CI II fracture of incisal edge. No restorations. | + + | Negative | Spontaneous pain of 3 days duration |
| 6 | 25 | Tooth #7. History of trauma. CI III Distal Resin Restoration. | + | Negative | Previous history of spontaneous pain |
| 7 | 21 | Tooth #9. History of trauma. Discolored. | + | Negative | Asymptomatic |
| 8 | 16 | Tooth #8. CI II fracture of incisal edge from trauma. No restorations. Tooth #9. CI II fracture of incisal edge from trauma. No restorations. | + | Negative | Asymptomatic |
| 9 | 31 | Tooth #8. Gold crown, History of trauma. | + | Negative | Severe pain and swelling |

TABLE 2
Clinical Testing and Tentative Diagnosis

| <i>Patient #</i> | <i>Electric Pulp Test</i> | <i>Percussion</i> | <i>Palpation</i> | <i>Sinus Tract</i> | <i>Clinical Impression</i> |
|------------------|---------------------------|-------------------|------------------|--------------------|--------------------------------|
| 2 | No response | Normal | Normal | — | Necrotic pulp |
| 3 | No response | Normal | Normal | — | Necrotic pulp |
| 4 | No response | Normal | Normal | — | Necrotic pulp |
| 5 | Tooth #8 no response | Sensitive | Sensitive | — | Necrotic pulp |
| | Tooth #9 no response | Sensitive | Sensitive | — | Necrotic pulp |
| 6 | No response | Sensitive | Normal | — | Necrotic pulp |
| 7 | No response | Normal | Normal | Healed | Necrotic Pulp |
| 8 | Tooth #8 no response | Normal | Normal | — | Necrotic pulp |
| | Tooth #9 no response | Normal | Normal | — | Necrotic pulp |
| 9 | No response | Sensitive | Sensitive | — | Necrotic pulp |

To determine the amount of fusobacteria (antigen) required to coat the wells of the microtiter plate and to determine a dilution at which the peroxidase labeled goat antisera should be used, a dual titration of doubling dilutions of antigen (0.25 to 10% whole cell suspensions) against serial 1:5 fold dilutions of conjugate was performed. An excess of reactive serum (1:100 dilution) was added to each well. A 1% suspension of fusobacteria and a 1:500 dilution of conjugate were found to be concentrations which would give an optimum yellow color and were the standard dilutions used for all subsequent experiments.

All serologic tests were performed in duplicate and when more than a one well difference was observed, testing of the serum was repeated. Determination of the mean titers and standard deviation as calculated after transforming the results from geometric progressions to arithmetic progressions (transformation from $1 \times 2^{n-1}$ to n) with the undiluted sera = 0, 1:20 = 1, 1:40 = 2, 1:80 = 3, etc.

ADSORPTION OF THE SERUM SAMPLES AND CONJUGATE WITH WHOLE CELL SUSPENSIONS OF *F. NUCLEATUM*

Whole cell *F. nucleatum* 10953 suspensions (1%) in PBS were mixed with an equal volume of 1:4 dilutions of human serum samples or 1:250 dilutions of the enzyme labeled anti-human heavy chain sera and incubated at 37°C for 1 h followed by refrigeration overnight. The mixtures were then centrifuged at $10,000 \times g$ for 10 min and the absorbed serum and conjugate used for serologic testing.

RESULTS

Gram stained smears of the samples obtained from the root canals of the pulpally involved teeth revealed predominantly gram + cocci and gram - rods (Table 3).

The results of the ELISA test using *F. nucleatum* strains and the sera from the endodontic patients and control individuals are seen in Table 4. Use of the Student T test and conversion of the titers to arithmetic progressions revealed that there was no significant differences between levels of antibody to *F. nucleatum* in the pre and post-treatment sera or between the pre and post-treatment sera and the sera from individuals without endodontic disease. The antibody titers in all patients and control individuals to both strains of *F. nucleatum* are consistent with a level of "natural antibody".

The presence in these sera of antibody reactive with both oral strains of *F. nucleatum* suggests these organisms share common antigenic determinants.

TABLE 3

Results of Gram Stained Smears of Root Canal Samples

| Patient # | Observations |
|-----------|-------------------------------------|
| 2 | gram (+) cocci, gram (-) rods |
| 3 | gram (+) rods, gram (-) rods |
| 4 | gram (+) cocci, gram (-) rods |
| 5 | gram (+) cocci, gram (-) rods |
| 6 | gram (+) cocci, gram (-) rods |
| 7 | negative |
| 8 | negative |
| 9 | gram (+) diplococci, gram (+) cocci |

TABLE 4

Detection of IgG Reactive with *F. nucleatum* 10953 and 10197 in the Serum of Patients with Endodontic Disease and in Orally Healthy Individuals by the ELISA Technique.

ELISA Results (IgG)

| Patient # | <i>F. nucleatum</i> | 10953 | <i>F. nucleatum</i> | 10197 |
|-----------|---------------------|-------------------|---------------------|-------------------|
| 2 | 1:40 ^a | 1:20 ^b | 1:40 ^a | 1:80 ^b |
| 3 | 1:80 | 1:80 | 1:0 | 1:20 |
| 4 | 1:20 | 1:40 | 1:20 | 1:40 |
| 5 | 1:80 | 1:40 | 1:80 | 1:40 |
| 6 | 1:40 | 1:20 | 1:40 | 1:40 |
| 7 | 1:40 | 1:40 | 1:40 | 1:40 |
| 8 | 1:80 | 1:40 | 1:40 | 1:40 |
| 9 | 1:20 | c | 1:20 | — |
| Control # | | | | |
| 10 | 1:20 ^d | | 1:20 ^d | |
| 11 | 1:40 | | 1:80 | |
| 12 | 1:20 | | 1:40 | |
| 13 | 1:40 | | 1:40 | |
| 14 | 1:40 | | 1:20 | |
| 15 | 1:40 | | 1:40 | |
| 16 | 1:40 | | 1:20 | |
| 17 | 1:20 | | 1:20 | |

a—serum samples taken at time of initial treatment

b—serums samples taken two weeks after completion of therapy

c—no datum

d—only one serum sample taken

There was no increase in antibody levels observed when comparing serum samples taken prior to obturation and two weeks after completion of the root canal therapy. There was no apparent difference in titers when comparing patients with lesions of endodontic origin and the control individuals. The test controls for the ELISA assay and removal of activity from the serum by the adsorption procedures suggested specificity of the reaction.

DISCUSSION

F. nucleatum strains have been one of the most frequent microbial isolates from pulpal infections.^{1,2,9-11} It was suggested that pulpal infection in teeth might allow a unique opportunity to study the immune response to *F. nucleatum*. It is a foci of infection rather than a chronic immunogenic insult (as in chronic periodontitis) and its inflammatory nature may result in a significant immune response.

Antibodies reactive with *F. nucleatum* have been detected in human sera.²⁸ The antibody observed to lipopolysaccharide was of the IgM class,^{28,29} with IgG antibody being demonstrated to a protein antigen, precipitinogen 2.^{30,31} Sonnenwirth³² in a review of the human antibody response to anaerobic bacteria suggested that IgG antibodies should be sought for serologic diagnosis of this group of microorganisms.

Gram-negative rods were frequently observed in the gram stained smears from the infected pulps. Sophisticated culturing techniques will be needed to identify and differentiate the various microorganisms present. Serologic studies with the patient's own identified pulpal microbial isolates in a longitudinal study should provide valuable information concerning the immune response during pulpal infections.

Antibody reactive with *F. nucleatum* was present in the sera of the endodontic patients. If *F. nucleatum* was present in the lesion both immune complex and lymphokine mediated aspects of pathology could occur.³³⁻³⁵ Also, direct activation of the alternative complement pathway by *F. nucleatum* lipopolysaccharide preparations³⁶ and cell walls³⁷ could result in subsequent pathologic changes. There appeared to be no differences in the antibody titers between individuals whether or not they had pulpal infections. Antibody did not increase after treatment of the infection, when antibody would no longer be complexing after antigen removal.

The role of immunologic reactions in pulpal infections is poorly understood. Identification of specific pulpal pathogens, their virulence factors and the immune response to them should provide a better understanding of the disease process.

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The Relationship Between Performance on a Test of Mechanical Insight and Psychomotor Achievement in Preclinical Laboratory Projects

Robert J. Leupold, D.M.D., M.A.

Frank C. Jerbi, D.D.S.

Elaine Romberg, Ph.D.

ABSTRACT

Since use of the chalk carving test was eliminated from pre-dental-admissions testing programs, educators have been searching for a simple, yet valid measure of psychomotor ability. At the University of Maryland, two hundred and twenty-four entering dental students were administered the "Survey of Mechanical Insight" to determine the validity of this test in predicting performance on preclinical laboratory projects. Laboratory grades in operative dentistry, crown and bridge, complete dentures and removable partial dentures were compared with test performance. Correlations show that the "Survey of Mechanical Insight" could be useful in identifying students who may require extra teaching assistance in performing their preclinical laboratory projects.

INTRODUCTION

Student performance in the psychomotor aspects of preclinical laboratory during the first two years of dental school is an unpredictable entity. In general it may be said that entering freshman students cannot be judged for their capabilities in this area simply by evaluation of their past academic records, Dental Aptitude Test scores or by a personal interview. The chalk carving test formerly given as a part of the Dental Aptitude Test is no longer used, leaving little data upon which to base a prediction for degree of achievement in the psychomotor domain for preclinical laboratory projects.

Peterson¹ has noted that with the demise of the chalk carving test, some dental schools are devising other methods of measuring manual dexterity. This study utilized a written test of mechanical insight to determine if there is a relationship between mechanical insight and psychomotor achievement. Thurstone² stated that "mechanical aptitude represents abilities that are often distinctly different from the verbal and memorizing abilities that characterize most school work. Mechanical aptitude is often found in individuals who have academic and verbal abilities but there are frequent exceptions. Many individuals with good attainment along academic and verbal lines are pathetically deficient in mechanical comprehension." He further noted that individuals may have superior abilities in mechanical aptitude but still be deficient in academic and verbal intelligence. He believes that mechanical aptitude is a complex of intellectual abilities defined by experience, interests and motivation. In a different study, Thurstone³ found that a test of mechanical aptitude could differentiate between those individuals with a high degree of mechanical ability and those with a low degree of mechanical ability. He indicated that the most significant component of mechanical aptitude was what he called the "second space factor." This factor is defined as the ability to visualize a flexible configuration; that is, to visualize a diagram or figure in which there can be internal movement or displacement of the parts. Internal movement includes motion which displaces only some of the parts as well as motion which displaces all of them. Thurstone's "Mechanical Movements Test" proved to have its only high correlation on this "second space factor." Zullo's⁴ factor analysis of perceptual and motor ability of dental students suggested that additional study be done in the area of aptitude testing of perceptual and motor skills.

If a significant correlation were found between a test of Mechanical Insight and achievement in the psychomotor aspects of laboratory projects during the first two years of dental school, it is conceivable that students having potential problems of achievement in this area could be identified early and steps taken to

reinforce their educational experience toward overcoming those problems. The purpose of this study was to determine whether there is a significant correlation between performance on a test of mechanical insight and preclinical laboratory project achievement during the first two years of dental school.

MATERIALS AND METHOD

The first year classes entering in 1978 and 1979 at the Dental School, University of Maryland were administered the multiple choice test entitled "Survey of Mechanical Insight" as devised by Daniel R. Miller.* This is a two dimensional test that measures the ability to predict resultant motion of various parts of a mechanism when a given part is operated. Scored on a scale of 0-100, the test is timed for thirty minutes. It contains 35 items of systems of levers, gears, pulleys and cams that present principles of mechanics in general application. Previous mechanical experience operates minimally in this test because the pictures do not depict machines that are currently being used. It can be administered to large groups; is non-manual in performance; can be scored with little effort and is not subject to practice effects. Spearman-Brown and coefficient alpha have yielded reliability scores in the high .80's. Validity coefficients in the .40's have resulted from comparison of scores on the survey with classroom performance in training programs requiring manual dexterity and/or mechanical ability. Correlation of scores with tests measuring similar skills fall in the .60's. No descriptive information such as mean and standard deviation are provided by the author or reported in the literature. The author does supply normative data in the form of percentile distributions but the sample on which this normative data was drawn is considered by reviewers to be too small to provide for useful comparisons. Therefore, it is inappropriate to provide this information to the reader. Examples of test questions are provided in Figs. 1 and 2. According to Thurstone,³ this is a test

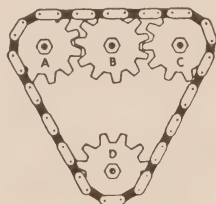


Figure 1. Sample Test Question

This mechanism cannot work. In order for the chain to move,

1. remove wheel B.
2. remove wheel A and adjust the size of the chain.
3. move wheel C away from wheel B and adjust the size of the chain.

that satisfies the most significant component of mechanical aptitude the second space factor.

The test was administered to all available students in both classes during the first week of school. In 1978, one hundred and nine students took the test and in 1979, one hundred and fifteen, for a total of 224 students. Each class was tested as a single group. During the first two years of dental school, final grades for these students were recorded on a scale from 0-100 for their laboratory practical examinations in the following areas: operative dentistry, crown and bridge, removable partial dentures, and complete dentures. These grades reflected pure manual skill without any didactic component.

In order to determine whether there is a correlation between performance by each student on this test of mechanical insight and the student's composite achievement grade in preclinical practicals, a pooled within-group Pearson Product Moment correlation was employed and analyzed to determine if the resultant correlation was significantly greater than zero.

Test Data was also grouped into deciles ranging from 100% to a category of below 50%. For each decile, the number of students achieving a low "C" average preclinical grade was compiled. A low "C" was 77% to 80%. The "C" grade range is 77% to 83%.

RESULTS

Grades on the test ranged from a low of 31% to a high of two scores of 100%. The following correlations between the Survey of Mechanical Insight and preclinical laboratory practical grades resulted. (Table 1). Operative dentistry practical grades showed a correlation of $r=.32$, crown and bridge practical grades, $r=.26$, partial denture grades, $r=.27$, and complete denture grades, $r=.36$. All correlations for the group were significant at the .01 level of probability.

When student scores on the test were matched with average preclinical grades, there was a pro-

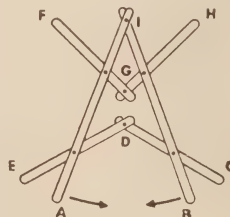


Figure 2. Sample Test Question

When A and B are moved together,

1. the distance between E and F increases.
2. the distance between C and E increases.
3. the distance between H and I increases.

TABLE 1

Pearson Product Moment Correlations between preclinical practical grades and scores on the Survey of Mechanical Insight

| <i>Preclinical Practicals</i> | <i>Correlation (r)</i> |
|-------------------------------|------------------------|
| Operative Dentistry | .32* |
| Crown and Bridge | .26* |
| Partial Dentures | .27* |
| Complete Dentures | .36* |

*All correlations significantly greater than zero, $p < .01$

gressive increase in the number of those having low preclinical grades as the test scores decreased. Only seven percent of the students scoring between eighty and one hundred received a low "C" while nineteen percent obtained a high "C"; thirty-nine percent, a "B"; and forty-seven percent, an "A". On the lower end of the scale of scores on the Survey of Mechanical Insight, forty-nine percent of the students with low "C's" scored below 60. Only twenty-seven percent, thirteen percent, and seven percent received a high "C", a "B", or an "A" in that order (Table 2).

DISCUSSION

The Survey of Mechanical Insight may be a useful tool in identifying the future behavior of dental students in pre-clinical laboratory projects. The predictive value is comparable to the highest correlations published in the literature for the PMAT section of the DAT⁵.

A factor that undoubtedly had an effect on the statistical analyses was that among the final grades

used, only five individual practical grades were below passing (77%) of a total of 896 grades. There were no final course grades of F (below 77%) recorded. Pre-clinical instructors were encouraging students to perform projects repetitively until they felt the students could meet minimal criteria for passing practical exams. The five grades below passing were all "75%" which tended to restrict the range of grades used in the study. There was no doubt however, that there were a group of students in each class who had difficulty in achieving at the minimal level of acceptability. In order to better identify this group, test grades were compared with student grades of low "C" (77-80%) as averaged from all their preclinical practical examination grades. As illustrated in Table 2, the greatest percent of low "C" grades occurred in the groups achieving less than 60% on the test. This may indicate that had a relatively normal practical examination grading curve resulted, statistical analysis may well have yielded higher correlation coefficients. As it was, students achieving less than 60% on the test proved to be possible candidates for additional teaching assistance.

The Survey of Mechanical Insight may be a useful, simply administered tool for identifying those dental students who may need additional teaching assistance in the psychomotor aspects of preclinical laboratory projects. The best use of the Survey of Mechanical Insight scores may be in identifying early in their dental career those students who are more likely to develop problems due to their lack of psychomotor skills. Students who scored less than 60% on the test were shown to be more likely to experience difficulty in carrying out their preclinical projects. That group of students should be monitored closely to recognize, as early as possible, the need for extra teaching assistance.

TABLE 2

Test grades compared to preclinical averaged grades
Student Preclinical Average

| <i>Survey of Mechanical Insight Grade</i> % | <i>Low C(77-80)</i> | | <i>High C(81-83)</i> | | <i>B(84-90)</i> | | <i>A(91-100)</i> | |
|--|-----------------------------------|------|-----------------------------------|------|-----------------------------------|------|-----------------------------------|------|
| | % of Preclinical N Grade Group | | % of Preclinical N Grade Group | | % of Preclinical N Grade Group | | % of Preclinical N Grade Group | |
| 90-100 | 0 | 0% | 1 | 2% | 17 | 11% | 4 | 27% |
| 80-89 | 1 | 7% | 7 | 17% | 43 | 28% | 3 | 20% |
| 70-79 | 2 | 14% | 10 | 24% | 34 | 22% | 5 | 33% |
| 60-69 | 3 | 21% | 13 | 31% | 39 | 26% | 2 | 13% |
| 50-59 | 4 | 29% | 4 | 10% | 14 | 9% | 0 | 0% |
| Below 50 | 4 | 29% | 7 | 17% | 6 | 1% | 1 | 7% |
| Total | 14 | 100% | 42 | 100% | 153 | 100% | 15 | 100% |

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Odontogenic Keratocysts

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ABSTRACT

Odontogenic keratocysts have attracted increased attention because of their high rate of recurrence and because they differ clinically and histologically from the majority of odontogenic cysts.

This study is based upon the examination of 90 odontogenic keratocysts. The histopathologic features, site, epidemiology and recurrence rate were observed and compared with the results of other studies. The incidence of keratocysts among the odontogenic cysts reviewed in this study was 4.7%. The recurrence rate in this study was 9%.

REVIEW OF THE LITERATURE

In 1956 Philipsen¹ proposed the name keratocyst for a group of odontogenic cysts with a histologic appearance and behavior strikingly different from other oral cysts. Previously they had been described under a variety of terms. In 1932 Rywkin² described a cholesteatoma of odontogenic origin. Catania³ reported in 1952 a recurrent dentigerous cyst with histologic features now recognized as those of an odontogenic keratocyst. More recently, interest has been centered on the incidence and the behavior of these cysts.

The prevalence of odontogenic keratocysts as a percentage of all odontogenic cysts has been reported as ranging between 3% and 17% of all odontogenic cysts⁴⁻¹² (Table 1).

Some investigators found no sex predilection in the occurrence of odontogenic keratocysts,^{5,13-15} while other studies showed that males were affected slightly more frequently than females.^{4,8} The peak incidence is in the second and third decades with isolated cases reported as early as 7 years of age and as late as 81 years of age.^{4,8,13-14}

Odontogenic keratocysts occur most frequently in the mandibular third molar and ramus areas.^{4,6-11,13,16-19} Maxillary cysts have been reported by some as occurring more frequently in the molar area^{8,10,20} while other studies indicate that the most frequent site in the maxilla is in the canine and premolar region^{13,17} or the anterior region.^{9,21} The antrum was the site of two odontogenic keratocysts reported by Donoff.¹⁴

CLINICAL MANIFESTATIONS

The odontogenic keratocysts are often asymptomatic^{8,11} however some studies have reported the presence of a hard, bony swelling.^{11,13-15,19} Pain, swelling, discharge and ulceration have been found to be associated with secondary infection of odontogenic keratocysts.^{12,13,19,22} According to Browne⁸ numbness of the lower lip on the related side was observed in two out of 65 patients with keratocysts.

RADIOGRAPHIC FEATURES

Many of the odontogenic keratocysts, especially the large ones, appear as multilocular radiolucencies resembling the ameloblastoma (Figures 1 and 2).^{11,12,17,18,22,23} The cysts are sometimes demarcated by a radiopaque border.^{8,17,18} Resorption of adjacent tooth roots may also occur.^{12,19,24} Displacement of the adjacent teeth has also been recorded.^{11,25} Expansion of the odontogenic keratocyst may be either at the expense of the buccal or lingual cortical plate.^{14,19,22,26} Bramley and Browne²⁵ found that the growth was predominantly in an antero-posterior direction rather than buccolingually. Cysts in the mandibular third molar region may extend to involve the whole ramus before bone expansion occurs.²⁷ Large cysts of the mandible were reported to extend superiorly to involve the entire coronoid process and the neck of the condyloid pro-

TABLE I. FREQUENCY of ODONTOGENIC KERATOCYSTS

| Author | Year | Total No. of Odontogenic Cysts | Keratocysts No. | % |
|--------------------------------|-------------------|-----------------------------------|--------------------|------|
| Pindborg et al. ⁵ | 1962 | 791 | 10 | 3.3 |
| Toller ⁶ | 1967 | 300 | 33 | 11.0 |
| Rud and Pindborg ¹² | 1969 | 366 | 20 | 5.5 |
| Browne ⁸ | 1970 ^a | 537 | 41 | 7.6 |
| Donoff et al. ¹⁴ | 1972 | 326 | 16 | 4.8 |
| Payne ⁹ | 1972 | 1313 | 103 | 7.8 |
| Radden & Reade ¹¹ | 1973 | 368 | 64 | 17.0 |
| Brannon ⁴ | 1976 | 2972 | 312 | 10.5 |
| Present Study | 1981 | 1904 | 90 | 4.7 |
| TOTAL | | 8877 | 689 | 7.8 |

cess.^{11,28} Mandibular cortical plates may become perforated due to destruction of bone by the enlarged cyst.^{14,19,25,26} Donoff¹⁴ reported two maxillary cysts which destroyed the floor of the antrum and invaded the maxillary sinus.

THE ORIGIN OF KERATOCYSTS

Odontogenic keratocysts may develop from remnants of the dental lamina, the epithelium of the tooth follicle or the epithelial rests of Malassez.^{7,13,17,18} Shear²⁷ and Toller⁶ believe that all odontogenic keratocysts originate from the enamel organ and thus all these cysts are primordial in origin.

Stoelinga and Peters²⁸ proposed that the oral mucosa plays an important role in the origin of many keratocysts and that these cysts may arise from epithelial hamartomas in the oral cavity. Pander and Hadders²¹ proposed that oral keratocysts are not odontogenic in origin but originate from the surface epithelium of the primitive oral cavity at the beginning of the formation of the dental lamina.

Recently Browne²⁹ suggested that the odontogenic keratocyst is derived from the dental lamina possibly as a hamartoma.

MACROSCOPIC FINDINGS AND NATURE OF THE CYST'S FLUID

The lumen of the keratocyst usually contains paste-like or pus-like fluid which, in fact, consists primarily of desquamated keratinized cells.^{6,18} Radden and Reade¹¹ described the content of the keratocysts they reviewed as having a characteristic odor. On the other hand Forssell, Sorvari and Oksala described the contents as odorless, caseous material.¹²

Electrophoretic studies showed that fluid aspirated from odontogenic keratocysts was characterized by a lack of soluble proteins^{6,8} while fluid from apical and dentigerous cysts contained low concentrations of soluble proteins.⁶ Other studies have shown that the fluid content of the keratocyst is very low in

soluble proteins compared to other odontogenic cysts.^{14,30,31,32}

Tissue culture studies have demonstrated that keratocysts have both an immunologically and biologically active collagenase in the cyst wall.¹⁴ A high level of collagenase may be the cause of the decreased tensile strength and rupture of the keratocyst wall.³³

HISTOLOGIC FEATURES

The epithelial lining of odontogenic keratocysts is very thin, consisting of 5 to 6 layers of cells with no rete pegs.^{3,5-6,11,14,17,27} The surface of the epithelium may be covered by a layer of orthokeratin or parakeratin, or both,^{13-14,26} although the keratinization is predominantly parakeratotic.^{5,16-17} The luminal layer of epithelium is often wavy,^{8,25} and keratin is frequently present within the cyst cavity.^{5-6,14,17,27,34}

The stratum spinosum is very scanty and sometimes is lacking.^{17,34} When the stratum spinosum is present many cells exhibit vacuolization.^{11,17} The basal cell layer is well-differentiated, and composed of either columnar or cuboidal cells^{6,18} with dark staining nuclei²⁴ which often exhibit reverse polarity.¹⁶

Although uncommon, the odontogenic keratocysts may also contain ciliated or mucous-secreting cells.^{10,13,16} In some cases the epithelium is found to be torn away from the underlying tissue.^{11,14,16,25}

In isolated areas the walls of these cysts are thickened and these areas are usually associated with irregular epithelial proliferation forming "daughter" cysts.^{9,20,25,28,35} Radden and Reade¹¹ observed budding and epithelial proliferation of the basal layer and found that these proliferations contained areas of dysplasia and dyskeratosis.

An association between keratinized cysts and squamous cell carcinoma has been reported.³⁶⁻³⁸ Toller⁶ postulated that "there would be a 15 times greater tendency for carcinoma to arise in" keratocysts but he stressed that the occurrence of carcinoma in any cyst is extremely rare. On the other hand, malignant change has also been observed in nonkeratinized odontogenic cysts.³⁹⁻⁴¹

The connective tissue adjacent to the epithelium usually shows little or no sign of inflammation.^{5,6} Occasionally areas of focal inflammation may be seen in the capsule of the cysts,^{16,25,35} as well as cholesterol crystals in the walls and in the contents of the cysts.^{6,16,35}

Mineralized masses were seen in 13% of the odontogenic keratocysts reviewed by Toller⁶ and Browne.¹⁰ Hyalin bodies were also seen in 9% of the cysts reviewed by Browne.¹⁶

RECURRENCE

The most significant clinical observation in studies of odontogenic keratocysts has been their high tendency to recur after surgical removal.^{2,42,43,44} The recurrence rate has been estimated to be between 12% and 62%.^{4,6,9,17,18,42} Recurrences arising in soft tissues and in bone grafts have been observed.^{23,26,43,44} The remarkable rate of recurrence may be due to incomplete removal of the cyst wall.^{2,22,25} Fragility of the thin cyst wall makes it likely that fragments of the cyst lining may remain following surgery.^{26,27,32} Satellite cysts, present in the cyst wall, if not enucleated, have the ability to proliferate and lead to recurrence.^{16,20,23-25,28,31} Pindborg and Hansen¹⁷ after studying serial sections of a number of keratocysts found no epithelial proliferation which could be interpreted as a possible explanation of the tendency of these cysts to recur.

It has been suggested that keratinized epithelial tissue has increased growth potential compared with the lining of nonkeratinized cysts.^{6,14,22,25} Recently Wright⁴⁵ suggested that the orthokeratinized variant of odontogenic keratocyst shows a more limited growth potential and lower recurrence rate than the parakeratinized variant. Hereditary influences have been implicated in the potential for keratocysts to recur in some individuals.^{8,9}

TREATMENT

Total excision is the treatment of choice according to most authors.^{12,21,11} Rud and Pindborg⁴² suggested that tooth roots in contact with a keratocyst should be extracted or at least closely observed at regular intervals. Some studies demonstrated no difference in recurrence rate following either enucleation or marsupialization of the keratocysts.^{18,42}

Persson²³ suggested that small multilocular lesions might best be treated by excision of a block of surrounding bone containing the lesion, while a multicentric lesion is best treated by subperiosteal extirpation of the affected bone followed by immediate bone graft.

Stoeltinga and Peter²⁸ recommended circumcission of the mucosa overlying the keratocyst and enucleation followed by cauterization of the bone cavity. McCann et al³⁴ used liquid phenol in the tissue surrounding the cyst to destroy epithelial residue, followed by 70% alcohol to neutralize the undesirable effects of the phenol.

The preoperative diagnosis of odontogenic cyst could help the surgeon in planning surgical treatment to reduce the recurrence rate. Fluid aspirated from the cyst could be examined for concentration of soluble protein³⁰ and, according to Toller,⁴⁶ a protein level

of less than 4 gm. per 100 ml. indicates that the lesion is an odontogenic keratocyst. The demonstration of keratinized squames in the cyst fluid also provides strong evidence to support a preoperative diagnosis of keratocyst.³⁰

Recently it has been suggested that combined use of radiography and radionuclide bone imaging, prior to surgical intervention would determine precisely the extent of the odontogenic keratocyst. This diagnostic method may ensure complete surgical excision and decrease the probability of recurrence.⁴⁷

MATERIAL AND METHODS

A review of 1,904 odontogenic cysts received by the Pathology Service at the University of Maryland from 1963 to 1980 revealed 90 keratocysts. These 1,904 odontogenic cysts included 958 periapical cysts, 687 dentigerous cysts, 150 residual cysts, 61 lateral periodontal cysts, 26 globulomaxillary cysts and 22 gingival cysts.

The surgical specimens had been fixed in 10% neutral buffered formalin embedded in paraffin, cut at six microns and stained with either hematoxylin, phloxine and saffron or hematoxylin and eosin. The blocks of nine keratocysts were chosen randomly from the 90 blocks available and stained using the Ayoub-Shklar⁴⁸ technique and Rhodamine B.⁴⁹ Control sections of keratinized skin and mucosal lesions, and non-keratinized odontogenic cysts were stained with the Ayoub-Shklar and Rhodamine B stains for comparison.

The criteria of Pindborg and Hansen¹⁷ for histologic characterization of keratocysts were used in the selection of this material. The criteria were:

1. The epithelial lining is usually thin, with no rete pegs.
2. The stratum corneum is often wavy with parakeratinization, orthokeratinization, or both.
3. The basal cell layer is well-defined and composed of either columnar or cuboidal cells.
4. The stratum spinosum is scanty with a direct transition of the basal cell layer to the superficial layer.

RESULTS

The incidence of keratocysts among the odontogenic cysts reviewed in this study was 4.7%. The incidence in the various types of odontogenic cysts is shown in Table II.

SEX AND AGE

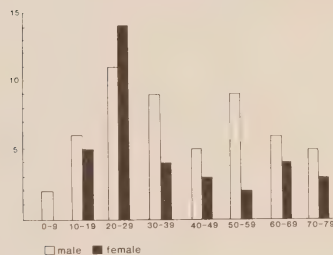
Of 88 patients with keratocysts 51 were males and 37 were females. The sex was unspecified in two cases (Table III). The overall male to female ratio was 1.4:1.

The age of the patients ranged from 8 years to 76 with a mean age of 39.55 years. The peak incidence was in the 3rd decade for both sexes (Table III).

TABLE II. DISTRIBUTION of KERATOCYSTS in ODONTOGENIC CYSTS

| Type of Cysts | No. of Cysts | No. of Keratocysts | Percent |
|-------------------------|--------------|--------------------|---------|
| Periapical | 958 | 6 | .61 |
| Dentigerous | 687 | 47 | 6.8 |
| Residual | 150 | 18 | 12.0 |
| Lat. Period./Primordial | 61 | 16 | 26.2 |
| Globulomaxillary | 26 | 3 | 11.5 |
| Gingival | 22 | 0 | — |
| TOTAL | 1904 | 90 | 4.7 |

TABLE III. SEX and AGE DISTRIBUTION of 88 PATIENTS with ODONTOGENIC KERATOCYSTS

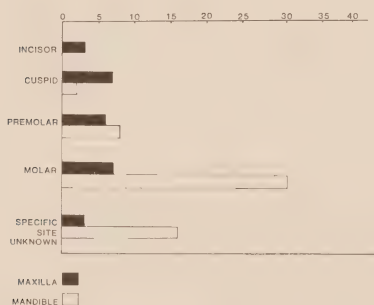


*Sex was unspecified in two cases.

LOCATION

Sixty-two of the cysts (69%) occurred in the mandible, while 26 (29%) occurred in the maxilla. The location of two cysts was not specified (Table IV). The most common sites were the molar and ramus region of the mandible (37%). One of the mandibular cysts

TABLE IV. DISTRIBUTION of 88 ODONTOGENIC KERATOCYSTS by SITE



extended from the ramus to the condyle.

In the maxilla the cysts were distributed equally between the anterior and posterior areas. Two cysts involved the maxillary sinus and one involved the tuberosity.

RECURRENCE

Recurrent cysts developed in 8 patients (9%). Seven patients had a single recurrence and one had multiple recurrences. To our knowledge only one of our patients exhibited the basal cell nevus-bifid rib syndrome. The interval between the diagnosis of the original lesion and the recurrence varied from 1 to 8 years.

HISTOPATHOLOGY

Parakeratinization was observed in 39 cysts (43%) and orthokeratinization was observed in 12 cysts (13%) (Figures 3 and 4). Alternating areas of parakeratin and orthokeratin were seen in 39 cysts (43%) (Table V).

Both parakeratin and orthokeratin were found in the 5 primary cysts which later recurred (62%). Of the nine recurrent cysts five (55%) exhibited parakeratin and 4 (45%) both parakeratin and orthokeratin. None of the recurrences exhibited orthokeratin (Table V).

TABLE V. STATE of KERATINIZATION in 90 ODONTOGENIC KERATOCYSTS

| | Original Cysts | | | Total |
|----------------------------|------------------------|---------------------|----------------|-------|
| | No Recurrence Observed | Recurrence Observed | Recurrent Cyst | |
| No. of Cysts | 73 | 8 | 9* | 90 |
| Parakeratin | 33 | 1 | 5 | 39 |
| Orthokeratin | 10 | 2 | — | 12 |
| Parakeratin & Orthokeratin | 30 | 5 | 4 | 39 |
| Orthokeratin in Lumen | 34 | 3 | 3 | 40 |

* one cyst recurred twice

The wall of 33 keratocysts (37%) consisted of dense collagen bundles. In 41 keratocysts (46%) the walls were cellular and contained loosely arranged collagen fibers. In 5 keratocysts (6%) the capsule varied in consistency exhibiting both loose and dense collagen. In 20 cysts (22%) hyalinization of collagen was observed.

Twenty-four cysts (27%) exhibited an intense inflammatory infiltrate; however, this infiltrate did not alter the surface epithelium. Mild inflammation was observed in 43 cysts (48%) (Figure 5). In 23 cysts (26%) the inflammatory infiltrate was absent or insignificant. Cholesterol clefts, giant cells, hyaline bodies and mineral deposits were frequent findings. The frequency of occurrence of all these features is summarized in Table VI.

Other capsular findings included satellite cysts and nests of odontogenic epithelium (Figure 6). Ten of 90 (11.1%) of the keratocysts examined contained satellite cysts in their walls, while 23 (25.5%) contained islands of epithelial rests. Thirteen keratocysts

(14.4%) contained both satellite cysts and solid nests of odontogenic epithelium (Table VII).

TABLE VI INCIDENCE of INFLAMMATION, CHOLESTEROL CLEFTS, HYALINE BODIES, GIANT CELLS and MINERAL DEPOSITS in 90 ODONTOGENIC KERATOCYSTS

| | No. of Keratocysts | Percent |
|--------------------------------------|--------------------|---------|
| Intense Inflammation | 24 | 27 |
| Mild Inflammation | 43 | 48 |
| Insignificant Amount of Inflammation | 23 | 26 |
| Cholesterol Clefts | 11 | 12 |
| Giant Cells | 7 | 8 |
| Hyaline Bodies | 21 | 23 |
| Mineral Deposits | 30 | 33 |

TABLE VII INCIDENCE of SATELLITE CYSTS and EPITHELIAL RESTS in 90 ODONTOGENIC KERATOCYSTS

| | Original Cyst | | | Total |
|---|------------------------|---------------------|----------------|-------|
| | No Recurrence Observed | Recurrence Observed | Recurrent Cyst | |
| No. of Cysts | 73 | 8 | 9* | 90 |
| Satellite Cysts | 9 | — | 1 | 10 |
| Epithelial Rests | 18 | 2 | 3 | 23 |
| Combination of Satellite Cysts and Epithelial Rests | 9 | 2 | 2 | 13 |

* one cyst recurred twice

In two cases of recurrent cysts satellite cysts were found in the walls of the original cysts as well as in the walls of recurrent cysts. In three cysts neither satellite cysts nor epithelial rests were found in the original or in the recurrence (Table VII).

Another feature of the keratocyst is enzymatic separation of the epithelium from the connective tissue capsule. In this study separation was observed in 42 cases (47%).

STAINING RESULTS

The following summarizes the results of staining with Ayoub-Shklar and with Rhodamine B:

1. The keratin closest to the stratum granulosum of control sections of keratinizing skin lesions stained positively (brilliant red) with the Ayoub-Shklar stain. However, fragments of more superficial and desquamated keratinized cells failed to conjugate with the stain.
2. All nine of the randomly selected keratocysts stained positively with Ayoub-Shklar stain. The distribution of the Ayoub-Shklar positive keratin was similar to that seen in the control sections, that is the keratin closest to the stratum granulosum was positive and the superficial keratin was negative. None of the

twelve randomly selected non-keratinized odontogenic cysts contained any Ayoub-Shklar positive material.

3. When stained with Rhodamine B and viewed with transmitted visible light, the keratin in the control sections of skin and mucosa stained with varying intensities of red. When viewed with transmitted ultraviolet light⁵⁰ the keratin in these sections fluoresced with an intense yellow glow.
4. Of nine keratocysts prepared and examined in the same manner as the controls, only one exhibited staining of the keratin with both visible and ultraviolet light. None of the twelve non-keratinized odontogenic cysts contained any Rhodamine B positive material.

DISCUSSION

The finding in this study that 4.7 percent of all odontogenic cysts were keratocysts is in agreement with the study by Donoff and his colleagues,¹⁴ but was somewhat lower than the results found in other reports (Table I). The difference may be explained by the fact that the odontogenic cysts reviewed in this report included 958 periapical cysts while in other studies few if any periapical cysts were included. The periapical cysts were the largest single category of odontogenic cysts but the prevalence of keratinization in these cysts was only 0.6%. Inclusion of the periapical cysts, in effect decreases the overall percentage of keratocysts. Other studies indicate that the prevalence of keratinized periapical cysts was 0–3%^{7,17}

Seven percent of the dentigerous cysts in this study were keratinized. In the literature the percentage of keratinizing dentigerous cysts varied from 7%⁵ to 32%.⁵¹

The relationship between primordial cysts and keratocysts is controversial. Some authorities believe that all primordial cysts are keratocysts,^{6,13,27} while others indicate the percentage of keratinization of primordial cysts varies between 44%⁴ to 75%.⁹ In this study we found that the percentage of keratocysts among primordial cysts was 26%. This lower percentage may be the result of our including the lateral periodontal cysts with the primordial cysts.

Twelve percent of the residual cysts in our collection exhibited keratinization. In the literature the percentage varies from 4%¹⁴ to 5%¹⁷. These statistics are interesting and imply that either these cysts are not as likely to be derived from periapical cysts as previously believed or their biology is altered as a result of their altered anatomic relationships.

Of twenty-six lesions from our files diagnosed as

globulomaxillary cysts, three were keratinized (11.5%).

While none of the gingival cysts in our material exhibited keratinization, the percentage of keratinization in gingival cysts cited in the literature ranged between 3%⁵⁰ and 16%.⁹

The variation in the incidence of keratinization in odontogenic cysts of all kinds cited in a variety of studies may be due to differences in criteria for cyst classification. This variation may also be due to random variation of an uncommon condition and the relatively few examples in most studies.

The male:female ratio in this study was 1.4:1. This result is in close agreement with the studies of Browne¹⁶ and Brannon.⁴ The age of the patients ranged from 8 to 76 with a peak incidence in the 3rd decade. Other studies showed approximately the same age range with a peak incidence in the 2nd and 3rd decade.^{4,7,8,10,11,16}

Seventy percent of the keratocysts in our study occurred in the mandible and 30% in the maxilla. In the literature the percentage of the mandibular keratocysts ranged from 65%⁴ to 83%.⁸ The present findings also agreed with other studies showing that most of the mandibular keratocysts occur in the molar region.^{4,7,8,10,11,16}

In the maxilla keratocysts are likely to be distributed equally between anterior and posterior areas. This observation by Brannon⁴ is confirmed in the present study.

The histologic appearance of keratocysts has aroused considerable interest in the hope that it would disclose some clue to the behavior of these cysts. In this study the majority of the keratocysts were either lined by parakeratin (43%) or by both parakeratin and orthokeratin (43%). Twelve of our keratocysts were lined by orthokeratin alone (Table IV). In the literature it was stated that keratocysts exhibiting only orthokeratin do not often recur.^{35,42} In this study the sample of recurrent cysts is too small to support that finding, but two of twelve keratocysts lined with orthokeratin did recur.

The wall of the cysts consisted either of dense collagen bundles, loosely arranged collagen fibers or a combination of both. Hyalinization of the collagen occurred in 22% of the cysts examined and the average age of the patients was 53 years. In other studies the occurrence of hyalinization of the collagen and the age of the patients are somewhat lower than ours.^{4,16} This finding supports the assumption that hyalinization appears to be a feature of keratocysts removed from older patients.

Only 23 cysts (26%) were free of any signs of inflammation. The remainder exhibited inflammation

of varying degrees of intensity (Table V). This finding is in conflict with the data of Browne¹⁶ who stated that the walls of keratocysts are characteristically free from inflammatory cells except for the presence of scattered foci. In another study Brannon⁴ found 33% of all keratocysts were free of inflammation.

Cholesterol clefts were found in 12% of all keratocysts (Table VI). This incidence is similar to the findings of Browne¹⁶ and of Brannon.³⁵ Other findings in the capsule of the cysts included satellite cysts, isolated nests of epithelium and budding of basal cells. The presence or absence of these findings either alone or in combination did not seem to have influence on the prognosis (Table VII). Some studies indicated that satellite cysts present in the cyst's wall, if not enucleated, have the ability to proliferate and lead to recurrence.^{16,20,23,24,25} Others found that there is no significant correlation between the observed presence of satellite cysts and the recurrence of the cyst.⁴

Twenty-seven keratocysts (47%) exhibited a separation between lining epithelium and subjacent connective tissue. This may provide some support for the findings of Donoff et al.¹⁴ and Browne and Miller³³ whose assumption was that the presence of collagenase in the keratocyst's wall may decrease its tensile strength.

Seven patients developed recurrences making the observed recurrence rate 9%. The interval between the diagnosis of the original lesion and the recurrence varied from 1 to 8 years. Compared to other studies the recurrence rate in this study is rather low (Table VIII). It should be noted, however, that several of the original 81 patients were lost to follow-up. Others with more recent cysts have a follow-up period as short as six months and are still at risk for recurrence.

TABLE VIII. RECURRENCE RATE OF ODONTOGENIC KERATOCYSTS FOUND BY VARIOUS AUTHORS

| Year | Author | No. of Keratocysts | No. of Recurrences | Percent |
|------|-----------------------------------|--------------------|--------------------|---------|
| 1963 | Pindborg and Hansen ¹⁷ | 16 | 10 | 63 |
| 1967 | Toller ⁶ | 33 | 19 | 58 |
| 1969 | Panders & Hadders ²¹ | 22 | 3 | 14 |
| 1970 | Browne ⁸ | 85 | 21 | 25 |
| 1974 | Forssell et al. ⁵⁰ | 38 | 11 | 29 |
| 1976 | Brannon ⁴ | 283 | 34 | 12 |
| 1981 | Present Study | 90 | 8 | 9 |

Efforts have been made to develop techniques that would make it easier to identify the keratin produced by the odontogenic keratocyst. In an effort to correlate reports relating to the Ayoub-Shklar and Rhodamine B techniques, keratin producing skin and mucous membrane lesions were compared with keratinized and non-keratinized odontogenic cysts.

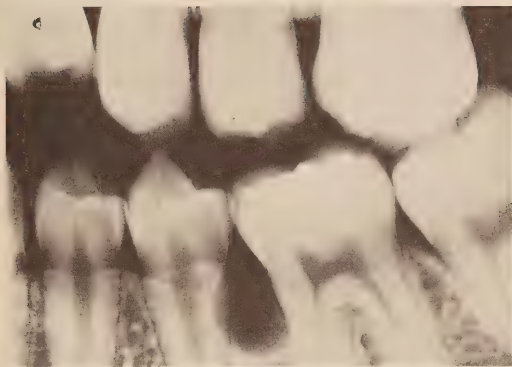


Figure 1. Radiograph of an odontogenic keratocyst (lateral periodontal cyst type) between the mandibular second bicuspid and the first molar. The cyst appears to be unilocular.



Figure 2. Radiograph of an odontogenic keratocyst. The cyst is multilocular in appearance and involves the mandible distal to the first molar and extends to the ramus.



Figure 3. Photomicrograph of the epithelial lining of an odontogenic keratocyst exhibiting a corrugated parakeratotic layer and thin spinous cell layer. (Hematoxylin and eosin stain. Magnification $\times 100$.)

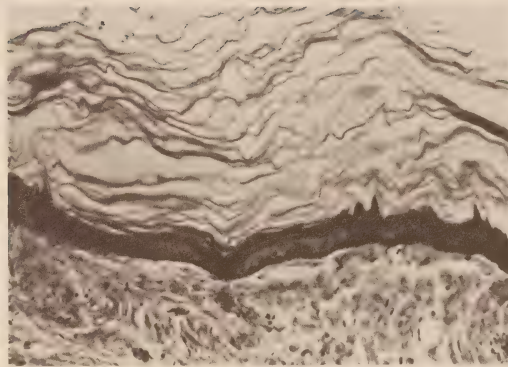


Figure 4. Photomicrograph of epithelial lining of an odontogenic keratocyst exhibiting a corrugated keratotic layer and thin spinous cell layer. Note the presence of keratin within the lumen. (Hematoxylin and eosin stain. Magnification $\times 100$.)



Figure 5. Photomicrograph of an odontogenic keratocyst capsule. Moderate inflammatory infiltrate, giant cells and cholesterol slits are seen. (Hematoxylin and eosin stain. Magnification $\times 50$.)



Figure 6. Photomicrograph of an odontogenic keratocyst capsule with a satellite cyst. (Hematoxylin and eosin stain. Magnification $\times 50$.)

The Ayoub-Shklar technique was not useful in distinguishing between the keratin in the keratocysts and the keratin of the skin and mucosal lesions. These stains may be of value in distinguishing between keratinizing and non-keratinizing cysts if an unequivocal diagnosis can not be made with hematoxylin and eosin.

The Rhodamine B technique, however, appears to be more specific for various types of keratin. It is specific for the keratin of the skin and oral mucosal lesions since all the control slides of keratin-producing skin and oral lesions stained positively with the stain; however, the stain did not conjugate with the keratin of the keratocyst lining. Therefore, this technique is of no value in distinguishing between keratinized cysts and non-keratinized cysts.

To some extent the usual behavior of odontogenic keratocysts is further confounded by the fact that certain important features of the cyst remain unreported in the literature. Since the initial reports that established the diagnostic criteria for odontogenic keratocysts, most studies have placed emphasis on the rate of recurrence and the histologic features of the cysts. The studies show that occasional examples of any of the cysts of the jaws may show the histologic features that are identified with odontogenic keratocysts. Despite the similarity of these cysts some recur and some do not. There is no evidence that keratinized periapical cysts have unusually high recurrence rates. On the other hand, there is some evidence that recurrences are most likely to occur from follicular cysts with the histologic features of keratocyst. The highest rate of recurrence is in the primordial (lateral periodontal) cysts, however because they are more common, dentigerous cysts produce the highest number of recurrent keratocysts.

In this study four out of sixteen primordial cysts recurred (25%), while only three of forty-seven dentigerous keratocysts recurred (6%).

Additional studies are needed in order to correlate recurrence rate with the clinical type of keratocysts, i.e., dentigerous, primordial or others.

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The 1980 William B. and Elizabeth S. Powell Lecture: On Purposes and Politics: Costs, Prices and Controls in the Personal Health Services Industry

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I thank you very much not only for the honor of being installed into the distinguished company of the Powell Lecturers who have preceded me but also for the opportunity of discussing with you certain aspects of an extremely complex set of problems which are justifiably engaging the attention of our legislators and government executives, our business leaders and, most importantly of all, our households.

Judged on the basis of the newsmedia, the omnipresent opinion polls, and the accelerating crescendo of rhetoric which seems to be coming from the nation's capital and from the capitals of a growing number of states as well, those of us who ply the health services trade are evidently in deep and serious trouble.

We are told with some annoying frequency, for example, that physicians and dentists are a self-centered and greedy lot of high technology gadgeteers who rush mindlessly about doing things to people (and primarily wealthy or employed people at that) with little or no knowledge or even much concern as to whether or not we cause more good than harm, that we are all but totally insensitive both to the human and spiritual needs of our patients and to the economic consequences of our acts, that our institutions are expressly structured so as to generate constantly escalating costs, and thus revenues, which gobble up increasingly greater percentages of gross national product without giving the public anywhere near its money's worth for investments already made and, at the bottom line, that people and governments alike would be a lot better off if our services were reserved for only very special occasions and emphasis were placed on preventive services, lifestyle change and self-help.

Or so, at least, it often appears.

It is a familiar argument. Theodore Roosevelt used it in his 1912 Bull Moose campaign when the issue of national health care was first politicized. And it is repeated all the time by all manners of special interest groups with all sorts of sharply conflicting proposals.

Notwithstanding, there is very little in the way of hard evidence that any society, whether industrialized or emerging, is particularly interested in rationing health services or, as a practical matter, is prepared to tamper in any significant way with the demand side of health-care markets, however imperfect these may (or may not) be. Everything points in precisely the opposite direction. So long as people are demonstrably sick, they are apparently more than willing to pay, and especially to have someone else pay, for almost any heroic effort whether or not the effort has any reasonable hope of being effective. Health-care is sick and, therefore, necessary care so far as most people are concerned. And it makes very little difference where in the political spectrum be-

tween market justice capitalism and social justice communism they happen to fall.

The facts seem perfectly clear: So long as most Americans continue to perceive the net present value of the *effectiveness* of sick-care programs to far exceed their *costs*—whether value is measured in social or political or psychological or ethical or even in economic terms—more, and preferably more of the same, will continue to be better. It is not a perverse accident of fate, in my judgement, that HMO's and the many ingenious HMO-like alternatives which are continually being invented have not caught the hearts or the imaginations or the pocketbooks of most people in the country, and certainly not of those of us who live and work east of the Mississippi River.

None of this comes, of course, as any great surprise to you. Our politicians and policy-makers have, after all, persisted for nearly four decades now in efforts to increase expectations and to increase demand and have succeeded handsomely in precommitting the vast majority of people, either by laws or by tax policies, to disregard both cost and price in making decisions about the utilization of sick-care services. The assumption has always been that the American economy is an ever expanding economic pie against which an ever expanding number and diversity of social claims can be made. At least, that was the assumption until the mid and late 1970's.

This should not prevent us, however, from trying to understand the pathogenesis of our current maladies in an unemotional context or discourage us from at least thinking about ways in which to deal constructively with what we are constantly reminded is an "unprecedented crisis" in health-care.

We can begin with costs.

Now, as you know, cost is an extremely slippery term. In pure form, and in a rigorous accounting sense, cost is simply a measure, expressed in monetary terms, of the amount of resources used for some carefully stated and clearly understood purpose, or cost objective. It is really a very simple construct.

Not very much information is conveyed, however, by the statement that "X" costs "Z" current or even constant dollars. The relevant consideration is that "X" costs either more or less than "Y" in terms of "Z" dollars and, therefore, that more or fewer resources, respectively, are required for "X" than for "Y".

Further, if more resources are required to purchase "X" than "Y", (whether by an expenditure of cash or by the exchange of another asset or by the incurrence of a liability) and thus a commitment to make a future expenditure then the product of the unit price of "X" and the number of units of "X" which

are bought or sold exceeds, by definition, the product of the price and quantity, the cost, of "Y". In short, cost equals price times quantity; and it makes no difference at all in an economic sense whether costs are used or consumed in the present accounting period and are thus expenses or whether they are used or consumed at some future accounting period and are thus classified as assets.

It is a matter of some considerable importance, therefore, in analyzing and understanding cost movements to be rather precise in distinguishing cost and price. Mixing the two, as is done all the time, only leads to bad accounting, bad economics, bad politics and, in the final analysis, to bad public policy prescriptions.

Now, anyone, in fact everyone, who can count and purportedly can compute simple percentages seems to know that the costs of our national health care enterprise are out of line and evidently going out of sight. I presume, therefore, that this means that the product of the price and the quantity of each of these services which are used are in some way disproportionate to the costs of other goods and services.

Well, let's look at the record. And to make matters as straightforward as possible, let us focus attention on only two measures of aggregate economic activity, gross national product and personal consumption expenditures for health care services (Table 1).

Gross national product or GNP is a statistical concept which is usually defined by the familiar $C + I + G$ notation. That is to say, gross national product is equal to the sum of personal consumption expenditures for goods and services (by far the largest component) plus gross private domestic investment in buildings, equipment and inventories, plus government purchases of goods and services, and plus (by far the smallest and usually forgotten component) net exports of goods and services.

Now, if we mean by "out-of-line" any movement in any subset of these four components which exceeds that of aggregate gross national product over a stipulated time frame, we can very quickly determine which national income account is, or is not, out of line with GNP. If we confine our interest to the 1950-1978 period, for example, it is quite clear that a number of personal consumption expenditure accounts were in fact out-of-line, as defined. Expenditures for health-care services were certainly out-of-line. But so were expenditures for housing, for transportation, and for gasoline and oil. Health-care was by no means the only national income account that was out-of-line with increases in GNP nor is it the only account that continues to be out-of-line.

TABLE 1

| | <i>Current Dollars in Billions</i> | | <i>Percent Change</i> |
|--|------------------------------------|-------------|-----------------------|
| | <i>1950</i> | <i>1978</i> | |
| Gross National Product | 286.2 | 2106.6 | 626.1 |
| Personal Consumption Expenditures for: | | | |
| Food | 53.9 | 269.2 | 399.4 |
| Housing ¹ | 21.7 | 207.2 | 854.8 |
| Health Care | 10.9 | 167.9 | 1442.6 ² |
| Motor Vehicles & Parts | 13.7 | 89.7 | 554.7 |
| Clothing & Shoes | 19.6 | 88.9 | 353.6 |
| Furniture & Household Equipment | 13.7 | 77.6 | 466.4 |
| Transportation | 6.2 | 52.7 | 750.0 |
| Gasoline & Oil | 5.5 | 51.1 | 829.1 |
| Fuel Oil & Coal | 3.4 | 14.8 | 335.3 |

Notes: ¹ Includes imputed rental value of owner-occupied dwellings

² Computed on basis of dollars in millions

Source: Bureau of Economic Analysis, U.S. Department of Commerce and Health Care Financing Administration, U.S. Department of Health, Education, and Welfare.

It can be argued with some reason, moreover, that the disproportionate increase in health-care services is in fact a distortion of the true state of affairs. Since personal consumption expenditures for health-care include direct or out-of-pocket payments and both private and public third-party payments, they are not strictly comparable to expenditures for housing or transportation or for gasoline and oil. Logic and proper accounting practice would indicate, at a minimum, that health expenditures made by federal, state and local governments in behalf of public beneficiaries should be excluded and reclassified as government purchases of goods and services. That is, of course, precisely what they are.

When this adjustment is made, some rather interesting and frequently overlooked phenomena rapidly become apparent (Table 2).

In the first instance, it is clear that health-related personal consumption expenditures of the direct or out-of-pocket after-tax type were anything but out of control or out-of-line between 1950 and 1978. As a matter of fact, they almost exactly paralleled increases in gross national product over the entire time frame. GNP increased, in terms of current dollars, 636% between 1950 and 1978 and out-of-pocket or direct consumption expenditures for health-care services increased, also in terms of current dollars, by 676% over the same time frame.

TABLE 2

Personal Consumption Expenditures for Health Care Services

| | | | | <i>Percent Change</i> |
|--|-------------|-------------|-------------|-----------------------|
| | <i>1950</i> | <i>1965</i> | <i>1978</i> | <i>1950-1978</i> |
| <i>In billions of current dollars:</i> | | | | |
| Total personal health care expenditures | \$ 10.885 | 37.267 | 167.911 | 1442.6 |
| Less: Government purchases | 2.440 | 7.880 | 65.042 | 2565.7 |
| Private direct and third-party payments | 8.445 | 29.387 | 102.869 | 1181.1 |
| Less: Private third-party payments | 1.312 | 9.487 | 47.553 | 3524.8 |
| Direct Payments | 7.133 | 19.900 | 55.316 | 675.5 |
| <i>As percent of gross national product:</i> | | | | |
| Government purchases | 0.9 | 1.1 | 3.1 | |
| Private third-party payments | 0.5 | 1.4 | 2.3 | |
| Direct Payments | 2.5 | 2.9 | 2.6 | |

Secondly, direct payments for health-care seminars remained essentially stable as a percentage of GNP over the entire period.

In sharp contrast, what clearly were out-of-line between 1950 and 1978 were what might be called the *entitlement expenditures* of government and private third-parties. Government purchases of health-care goods and services, for example, increased by more than 2500% and private third-party expenditures increased by more than 3500% between 1950 and 1978. Government health-care purchases increased from less than 1% of GNP in 1950 to more than 3% in 1978, and private third-party expenditures increased from about one-half of one percent of GNP in 1950 to almost 2½% of GNP in 1978.

The point is worth repeating: Between 1950 and 1978 private out-of-pocket expenditures for health-care goods and services increased in direct proportion to increases in GNP. They represented approximately 2½% of GNP in 1950 and 2½% of GNP in 1978. In the same period, entitlement expenditures made by both private and public third-parties in behalf of employees and government beneficiaries increased at a very significant multiple, more than quadruple, that of the increases in GNP. Increases in government purchases

exceeded GNP increases by a multiple of almost 4 and increases in private third-party purchases exceeded GNP increases by a multiple of slightly more than 5.

Put into historical perspective, there was, first, an explosion in private third-party payments and, then, in public third-party payments; and the explosion seems to have involved all elements of the personal health-care services industry. There were massive and unbalanced entitlement payments for hospital services, physicians' services, and for all other services. Only direct or out-of-pocket payments, whether for hospital, physician, or other services, were in reasonable balance with increases in gross national product. Entitlement expenditures for hospital care increased, as a percentage of GNP, nearly 4 times between 1950 and 1978 and entitlement expenditures for physicians' and other services increased approximately 5 times in this same time frame (Table 3).

Entitlement rights and entitlement expenditures seem, in consequence, to have accounted for essentially all of the disproportionate increases in the costs of health-care services since 1950. And herein, of course, lies the crux of the health-care cost problem.

As people's expectations of demonstrably visible

TABLE 3
Personal Consumption Expenditures

| Percent Change | Billions of Current Dollars | | | As Percent G.N.P. | |
|---|-----------------------------|---------|----------------|-------------------|------|
| | 1950 | 1978 | Percent Change | 1950 | 1978 |
| Total personal health care expenditures | | | | | |
| Hospital care | 3.851 | 76.025 | 1874.2 | 1.3 | 3.6 |
| Physician's Services | 2.747 | 35.250 | 1183.2 | 1.0 | 1.7 |
| All other services ¹ | 4.287 | 56.637 | 1221.1 | 1.5 | 2.7 |
| Total | 10.885 | 167.912 | 1442.6 | 3.8 | 8.0 |
| Less: Entitlement expenditures | | | | | |
| Hospital care | 2.699 | 68.492 | 2437.7 | 0.9 | 3.3 |
| Physician's services | 0.462 | 23.237 | 4929.7 | 0.2 | 1.1 |
| All other services | 0.592 | 21.866 | 3593.6 | 0.2 | 1.0 |
| Total | 3.753 | 113.595 | 2926.8 | 1.3 | 5.4 |
| Direct payments | | | | | |
| Hospital care | 1.152 | 7.533 | 553.9 | 0.4 | 0.4 |
| Physician's services | 2.285 | 12.013 | 425.7 | 0.8 | 0.6 |
| All other services | 3.695 | 35.771 | 868.1 | 1.3 | 1.7 |
| Total | 7.132 | 55.317 | 675.6 | 2.5 | 2.6 |
| Gross National Product | 286.2 | 2106.6 | 636.1 | | |

¹ Includes drugs and drug sundries, eyeglasses and appliances, nursing home care and other professional services.

benefits of health-care services have risen, however unrealistic and occasionally absurd they may be from a purely biological point of view, effective demand has increased for entitlement rights to ever more services. Americans obviously want (and in fact get) increasingly sophisticated and complex and available services, but we apparently want these services only to the extent that their costs are borne by some private or public third-party. On the record of performance, we do not seem to value incremental services highly enough to pay for them out of net after-tax dollars.

Let us turn now to the price component of the price-quantity-cost equation (Table 4). If costs are severely out-of-line with GNP movements, which they clearly are and have been, according to our definition, then it must follow from what we said before that either pricing structures or the quantity of health-care services which are bought and sold, or both, are also out-of-line. There are, after all, only a finite number of ways in which the cost equation can be manipulated.

As is obvious from Table 4, but unfortunately does not appear to be generally known or acknowledged, physicians' fees, dentists' fees and the prices of hospital semiprivate rooms were all significantly underpriced relative to general price levels (that is, the "all terms" columns) throughout the entirety of

the private insurance period. Hospital prices, in fact, were severely depressed with respect to general price levels in the early phases of the period and, though rapidly increasing, nonetheless remained underpriced throughout the period.

You have no doubt noticed that prices for dentists' services, while underpriced relative to general price levels, were actually overpriced relative to prices for consumer services excluding rent until about 1960. And I suspect that you have also noticed that these latter prices not only became, but have also remained, underpriced ever since. There is, in fact, some suggestive evidence that the prices of dentists' services have actually declined relative to the prices of consumer services less rent in a steady manner for perhaps the past 20 years. The relative price index was 115.6 in 1948 and fell steadily to 90.3 in 1978. And, as is apparent here, dentists' fees-for-service have roughly paralleled price levels for all consumer items for the past 10 years or so. At no time have they exceeded general price levels by more than about 1 or 2 percent.

Physicians' fees, on the other hand, which were definitely underpriced in the private insurance period, have increased in a slow but steady manner with respect to general price levels and, to a lesser extent, with respect to the prices of consumer serv-

TABLE 4
Relative Consumer Price Indices (CPI-W)
(1967 = 100)

| | Year | (All Items) | | | (Consumer Services) | | |
|--------------------|------|------------------|----------------|---------------------|---------------------|----------------|---------------------|
| | | Physicians' Fees | Dentists' Fees | Hospital S.P. Rooms | Physicians' Fees | Dentists' Fees | Hospital S.P. Rooms |
| <u>Private</u> | | | | | | | |
| | 1945 | 85.3 | 92.0 | 32.7 | 102.0 | 110.0 | 39.0 |
| <u>Entitlement</u> | 1948 | 74.1 | 83.2 | 37.4 | 102.9 | 115.6 | 52.0 |
| | 1951 | 73.7 | 85.3 | 43.1 | 96.6 | 112.0 | 56.5 |
| <u>Era:</u> | 1954 | 78.5 | 89.8 | 50.4 | 94.8 | 108.4 | 60.9 |
| | 1957 | 83.4 | 90.4 | 57.4 | 95.9 | 104.0 | 66.0 |
| | 1960 | 86.8 | 92.8 | 64.6 | 94.0 | 100.2 | 70.0 |
| | 1963 | 90.6 | 95.0 | 74.8 | 95.2 | 99.8 | 78.6 |
| | 1966 | 96.1 | 97.9 | 85.9 | 98.0 | 99.9 | 87.6 |
| | 1969 | 102.8 | 102.8 | 117.3 | 99.2 | 99.2 | 113.2 |
| <u>Public</u> | 1972 | 106.8 | 105.6 | 138.8 | 98.5 | 97.4 | 128.0 |
| | 1975 | 105.1 | 100.4 | 146.5 | 98.5 | 94.2 | 137.3 |
| <u>Entitlement</u> | 1976 | 110.6 | 101.0 | 157.5 | 100.9 | 92.2 | 143.8 |
| | 1977 | 113.5 | 102.0 | 165.0 | 102.2 | 91.8 | 148.6 |
| <u>Era:</u> | 1978 | 114.2 | 101.4 | 170.1 | 101.7 | 90.3 | 151.5 |

Source: Bureau of Labor Statistics, U.S. Department of Labor.

ices less rent on an almost annual basis following enactment of the Medicare and Medicaid entitlements. They have been moderately overpriced throughout the public entitlement era relative to most other prices, including those of dentists' services.

What we have had, then, is a progressive and sustained increase, following a decrease during World War II, in the relative pricing structures of underpriced physicians' and dentists' services during the private entitlement period and what might be called a modest-but-mounting overpricing of physicians' fees (but not of dentists' fees) in the public entitlement period.

An entirely different, and frankly unique, situation seems to have applied so far as the hospital industry is concerned. In hospitals, what we have amounts to a self-reinforcing demand-pull inflation in prices which has been fueled by and appears to be directly attributable to: (1) *financing mechanisms*, which reimburse hospitals for care and services rendered at or in relation to their averaged per diem plant capacity costs quite irrespective of the nature, scope or volume of services which are actually provided; (2) *private and public insurance coverage*, which stimulates increasing demand for inpatient and much outpatient care by reducing the net out-of-pocket prices of hospitals care to levels which more than 90 percent of the population interprets as being "free" of any significant change; and (3), perhaps most importantly, *government tax policies*, which encourage the purchase of ever more comprehensive private insurance—first, by allowing employed individuals to deduct about half of the premiums they pay for health insurance from taxable income; and second, by excluding premiums paid by an employer in behalf of an employee not only from corporate taxable income but also from social security and state income taxes as well.

It is not very surprising, looking back, that a very remarkable and consistent pattern emerged at the end of World War II. During the war, group health insurance became an important component of collective bargaining. Even greater impetus for growth in insurance coverage for hospital and surgical expenses and for regular and major medical expenses came in the postwar period when the U.S. Supreme Court ruled that employee benefits, expressly including health insurance benefits, were a legitimate part of the labor-management bargaining process. And, after that, it was Katie-bar-the-door, first for employed persons and their families and then, with public insurance, for a wide variety of aged, low income and other explicitly defined beneficiaries.

In 1950, 77 million people had hospital expense insurance. By 1977, less than three decades later, the

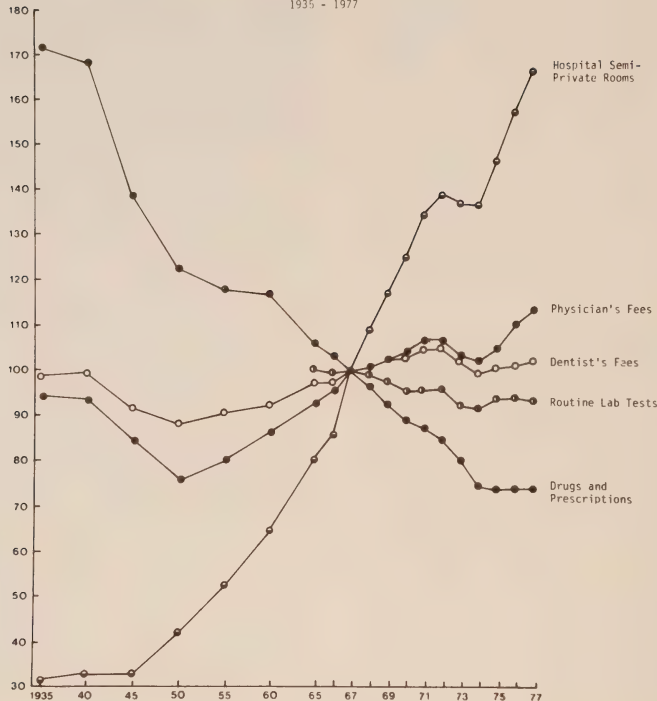
net number of different people covered by similar insurance protection had risen 130% to 177 million, representing more than 8 out of 10 of the civilian noninstitutional population. Hospitals exploited the continuous explosion of federally-financed scientific knowledge and constantly increased the complexity, sophistication, intensity and reimbursable input costs of the products and product lines which they offered for sale. Insurance carriers, both profit-seeking and tax-exempt, guaranteed that all input costs would be reimbursed in full and on a reasonably timely basis with only little in the way of retroactive denial of claims, and then simply passed the continually escalating direct and administrative costs of paying bills along to second-party employers and subsequently to the public at large. Finally, well and worried well and overtly sick insurance beneficiaries, having been freed of financial and related barriers to readily available, equitably distributed and high quality hospital care at effectively zero out-of-pocket cost to themselves, rapidly discovered that increasing use of hospital care services was an inborn and inalienable right of citizenship as well as employment.

The net economic effect (Figure 1). has been an inexorable increase in hospital prices ever since the end of World War II. Interestingly, and I believe importantly, the fitted exponential curve which best describes growth in prices of hospital semiprivate rooms since about 1945 does not show any perturbations at all associated either with the enactment or the implementation of Medicare and Medicaid and the start of what we have called the public entitlement period. The only material break in the continuity of the actual growth curve occurs substantially later, between late 1971 and early 1974, during the time of President Nixon's Economic Stabilization Program. In all other respects, the curve suggests that hospital prices have simply increased at a more or less constant rate, year in and year out, for the past thirty to forty years.

This growth in hospital prices stands, quite obviously, in stark contrast to the behavior of prices for routine laboratory tests and for drugs and prescriptions and makes discussions of the behavior of dentists' or even physicians' fees matters of academic rather than of public policy interest.

Now, it is easy, of course, to lay all blame at the feet of self-centered doctors and selfish hospitals and to attempt to control total costs by placing caps or other limitations on physician and hospital prices and revenues. It is easy, but it is not very sensible and, because it is not very sensible, I am inclined to think that it is not likely to work in any normative sense or to work for any significant period of time despite mounting efforts in this regard especially at the state

RELATIVE PRICE INDICES
1935 - 1977



government level. Cost, as we have discussed, is a function of both price and quantity; and it is essential in efforts to control costs that one has a reasonably accurate understanding of whether it is primarily price factors, or primarily quantity factors, or both, that are responsible for health-care cost escalations.

The situation so far as dental services are concerned seems to be reasonably uncomplicated, primarily because insurance has not played a major role, and provides what I believe is an appropriate model for analyzing what has happened in the medical care and hospitals industries. Absent widespread, though increasing, insurance coverage for general much less specialized dental care, we can get some notion of the impact of rising expectations as a relatively isolated and independent variable and then can speculate on the perhaps likely shape of things to come in the dental care industry.

Total expenditures, and thus both expired and unexpired costs, for dental care services increased, by approximately 1300 percent between 1950 and 1978 (Table 5). In the same interval, gross national product increased by about 460 percent or just about one-half the comparable increase in dental care expenditures.

Prices of dentists' services, however, only increased by 210% or by about the same amount as did consumer prices generally. That is to say, while expenditures for dentists' services doubled with respect to gross national product, the prices of these services increased more or less in parallel with general price levels. It seems reasonably safe to conclude, in consequence, assuming the basic validity of the cost equals price times quantity equation, that the observed increase in total national expenditures for dentists' services between 1950 and 1978 is largely a reflection of a doubling in the number or quantity of services which were provided in this period. Price increases do not seem to have played a major role in cost increases, and thus cost increases are probably ascribable principally to quantity or utilization increases.

A somewhat different situation applies in other health-care sectors. Physicians' services also demonstrated a doubling phenomenon in expenditures between 1950 and 1978 when compared to increases in GNP. But the prices of physicians' services also manifested a substantial increase. Whereas the relative price multiple for dentists' fees was 1.2, rounded off to 1 times the increase in general price levels, the

TABLE 5
Personal Health Care Expenditures and Prices

| | <i>Expenditures¹</i> | | | | <i>Prices²</i> | | | |
|---------------------------------|---------------------------------|-------------|-----------------------|-----------------|---------------------------|-------------|-----------------------|-----------------|
| | <i>1950</i> | <i>1978</i> | <i>Percent Change</i> | <i>Multiple</i> | <i>1950</i> | <i>1978</i> | <i>Percent Change</i> | <i>Multiple</i> |
| Hospital care | 3.851 | 76.025 | 1874.2 | 2.9 | 30.3 | 332.4 | 997.0 | 5.8 |
| Physicians' services | 2.747 | 35.250 | 1183.2 | 1.9 | 55.2 | 223.1 | 304.2 | 1.8 |
| Dentists' services | 0.961 | 13.300 | 1284.0 | 2.0 | 63.9 | 198.1 | 210.0 | 1.2 |
| All other services ³ | 3.326 | 43.337 | 1203.0 | 1.9 | N/A | N/A | N/A | N/A |
| Total ⁴ | 10.885 | 167.912 | 1442.6 | 2.3 | 53.7 | 219.4 | 308.6 | 1.8 |
| Consumer Price Index | | | | | | | | |
| Gross National Product | 286.2 | 2106.6 | 636.1 | — | 72.1 | 195.4 | 171.0 | — |

Notes: ¹ In billions of current dollars

² Consumer price indices (1967 = 100)

³ Includes drugs and drug sundries, eyeglasses and appliances, nursing home care and other professional services.

⁴ Consumer price indices for "all items of medical care" (1967 = 100)

Source: Health Care Financing Administration, U.S. Department of Health, Education and Welfare.

price multiple for physicians' services was 1.8 or roughly twice that of general price levels. It would appear, accordingly, that a combination of quantity increases and price increases best accounts for the cost or expenditure increases which were experienced in physicians' services between 1950 and 1978.

A similar type of combined price-and-quantity effect seems to have been operative in the hospital industry as well. The magnitude of increases in costs and prices, however, were very substantially different. Expenditures for hospital care services increased at a cost-multiple approximately three times that of the GNP increase and prices increased at a price-multiple nearly six times that of the comparable increase in general price levels.

We seem, therefore, to have experienced cost increases in the personal health services industry which rather accurately reflect the extent and scope of insurance coverage which is generally available to the public at large. Where broad segments of the population have extensive insurance coverage and where few alternatives for care exist, as in the case of protection against hospital and surgical expenses, cost increases appear to be due both to large increases in utilization or quantity and to even larger increases in prices. Where insurance coverage is less widespread and less comprehensive, as in insurance coverage for physicians' services, quantity increases and price increases appear to be roughly equal partners in ac-

counting for cost increases. And where insurance coverage is limited in nature, scope and the net number of different persons covered, and where many alternatives for care—or no care at all—appear to exist, as in the case of dentists' services, quantity increases appear to be the principal, if not exclusive, cause of the cost increases which are realized.

We are back, then, to entitlement rights. As entitlement rights are expanded and progressively increasing numbers of people are entitled to care, utilization increases, and as utilization increases, at least in the health-care industry, prices increase. Demand and supply factors are self-reinforcing.

Current political efforts to expand insurance coverage and, simultaneously, to "control" both costs and prices take on, in consequence, many of the attributes of a theater of the absurd, a kind of Alice-in-Wonderland fantasy. If cost increases are due in the first instance to quantity increases, as relevant historical data seem to suggest, it hardly seems likely that total costs will be reduced by an expansion of benefits, even if the benefits are limited only to some form of coverage for catastrophic illness. Precisely the opposite would be expected.

Further, if utilization is really the issue, it does not appear overwhelmingly sensible to focus governmental efforts at cost moderation or cost control, whether at the federal or state level, principally on the price side of the cost equation. Yet, this is what we

have always done, from World War II on, and no doubt will continue to do in the future. Legislators and bureaucrats evidently find it a good deal easier, and very much more comfortable, to stand metaphorically in a hospital administrator's door than to stand squarely at a hospital entrance.

Look, further, at what happened during the various voluntary and then mandatory phases of President Nixon's Economic Stabilization Program (Table 6). Our experience seems only to prove, once again, why wages and price controls, or income policies, only work in times of war: When there is a commonly perceived need to work for the common good or when large groups of people recognize a need to bring inflation under control, there is usually little difficulty in achieving defined goals over the short run. Over the longer run, however, the spirit of vol-

untary self-sacrifice tends to wane and eventually dissipates, particularly as people begin to perceive controls as unfair and/or unrealistic and/or nonsensical.

Controls were clearly associated with a politically desirable decrease in the price levels of physicians' fees, dentists' fees and hospital semiprivate room prices in all 11 quarters of the Economic Stabilization Program, between the third quarter of 1971 and the first quarter of 1974.

During the first five quarters of the Economic Stabilization Program, from the third quarter of 1971 through the fourth quarter of 1972, which roughly corresponds to mandatory Phases I and II of the Program, prices for physicians' fees grew at a compound rate of 0.6 percent per quarter. In the last five quarters of ESP, however, which roughly approximate the so-

TABLE 6

Consumer Price Indices for Personal Health Care Services Before and After the Economic Stabilization Program
(1967 = 100)

| <u>Period</u> <u>Year & Quarter</u> | <u>Physicians' Fees</u> | | <u>Dentist's Fees</u> | | <u>Hospital S.P. Rooms</u> | |
|--|-------------------------|----------------|-----------------------|----------------|----------------------------|----------------|
| | <u>Actual</u> | <u>Fitted*</u> | <u>Actual</u> | <u>Fitted*</u> | <u>Actual</u> | <u>Fitted*</u> |
| <u>E.S.P. (Controls)</u> | | | | | | |
| 1971 Q3 | 131.5 | 132.1 | 128.2 | 128.4 | 166.8 | 167.3 |
| Q4 | 132.2 | 134.2 | 130.0 | 130.4 | 167.9 | 171.7 |
| 1972 Q1 | 132.9 | 136.2 | 131.0 | 132.4 | 172.2 | 176.1 |
| Q2 | 133.9 | 138.3 | 132.4 | 134.5 | 173.8 | 180.4 |
| Q3 | 134.4 | 140.4 | 133.1 | 136.6 | 175.6 | 184.8 |
| Q4 | 135.4 | 142.4 | 133.7 | 138.7 | 176.3 | 189.1 |
| 1973 Q1 | 136.7 | 144.4 | 134.7 | 140.8 | 180.1 | 193.4 |
| Q2 | 138.0 | 146.4 | 136.1 | 143.0 | 181.4 | 197.7 |
| Q3 | 139.6 | 148.4 | 137.0 | 145.2 | 183.6 | 202.0 |
| Q4 | 140.8 | 150.4 | 138.6 | 147.5 | 186.4 | 206.3 |
| 1974 Q1 | 145.0 | 152.4 | 141.5.149.8 | 191.4 | 210.5 | |
| <u>Post-Controls:</u> | | | | | | |
| 1974 Q2 | 150.3 | 154.3 | 145.7 | 153.2 | 198.4 | 214.8 |
| Q3 | 155.9 | 156.3 | 150.5 | 154.5 | 209.6 | 219.0 |
| Q4 | 159.5 | 158.2 | 154.5 | 156.9 | 217.1 | 223.2 |
| 1975 Q1 | 165.0 | 160.1 | 158.7 | 195.4 | 227.8 | 227.4 |
| Q2 | 168.8 | 162.0 | 161.8 | 161.8 | 232.8 | 231.5 |
| Q3 | 172.9 | 163.9 | 164.1 | 164.3 | 243.2 | 235.7 |
| Q4 | 178.3 | 165.7 | 166.5 | 166.9 | 249.1 | 239.8 |
| 1976 Q1 | 184.3 | 167.6 | 169.4 | 169.4 | 261.5 | 243.9 |
| Q2 | 188.3 | 169.4 | 171.6 | 172.0 | 265.1 | 248.0 |
| Q3 | 192.2 | 171.2 | 174.5 | 174.7 | 275.2 | 252.1 |
| Q4 | 195.6 | 173.1 | 177.9 | 177.4 | 281.5 | 256.2 |

* Projected on the basis of triple-exponentially smooth data for all quarters beginning with the first quarter of 1950 (1950 Q1) and ending with the second quarter of 1971 (1971 Q2).

called voluntary Phases III and IV, prices for physicians' fees grew at a rate of 1.4 percent per quarter, or at a rate nearly 2½ times that observed in the mandatory phases of the Program.

Dentists' fees increased at a rate of 0.9 percent per quarter in the voluntary period. Prices of dentists' services thus grew during the voluntary controls period at a rate approximately 1½ times that experienced during the period of mandatory controls.

Prices for hospital semiprivate rooms, interestingly, grew at about 1.4 percent per quarter during mandatory controls and only at about 1.5 percent per quarter during voluntary controls.

Prices for all professional services, as noted here, were lower during all phases of the Economic Stabilization Program than the fitted projections of prices based on historical trends between the first quarter of 1950 and the second quarter of 1971. Six months after controls were lifted, however, prices of physicians' fees exceeded the projections based on 1950-1971 quarterly trends and have remained higher than projected levels ever since.

Hospital semiprivate room prices were also reduced during the 11 quarters of the ESP and, contrary to much conventional wisdom, did not become abnormally priced relative to projected prices until the first quarter of 1975. Since then, however, hospital prices have simply climbed out of all proportion.

The "white hats" in this scenario are, of course, prices for dentists' services. Dentists' fees were reduced during the ESP but, in clear distinction to physicians' fees and hospital prices, have subsequently only come up to, but have not as yet exceeded, forecasted levels of prices based on historical trends over the course of the 1950-1971 period.

So, here again, we see the effects of increasingly comprehensive health insurance. Galloping prices and "catch-up" bulges in prices seem to have been limited, in fact confined, to sectors in which insurance coverage is most comprehensive and widely available.

Now, given this somewhat elementary but I hope instructive analysis, and assuming that it is basically correct in most respects, the critical question is: What, if anything, are we prepared to do about it? Are we really serious about controlling both prices and the number of services provided, and are we really willing, as we allege we are, to do whatever is necessary to control continually escalating costs which bear little or no relation to general economic conditions? Frankly, I have my doubts, and the best answer that I can give would be: "yes, but..."

"Yes," I do believe that health-care costs are perceived by a large percentage of the population to be

out of hand, and "yes" I do believe that we are serious about devising some means of controlling or moderating these costs, "But, no" I do not believe that we are really willing to trade off entitlement rights and the traditional social liberalism underlying entitlement rights for economic rationality even if entitlement rights can be unequivocally demonstrated to be the root cause of our unwanted cost and price inflation.

It would be foolish to believe that entitlement rights, when once won and reaffirmed, are likely to be revoked, even in time of hot war. They become part and parcel of our heritage and our culture, as much as our body of law, and they are withdrawn only at the gravest of perils. I would suspect, therefore, that only a very few especially courageous and politically naive people will openly advocate explicit rationing of health-care services as the most desirable means of curtailing continuing increments in health-care costs.

Implicit rationing, on the other hand, may be quite another matter. Our good friends in OPEC have perhaps taught us something of considerable importance over the course of the past several years. Not the least is that we are not entitled to anything either at low or no cost. Not fuel oil and, I would submit, not even health-care services. We are, I believe, at long last beginning to realize that there is no such thing as a free lunch; one does, in the final reckoning, have to pay for the beer.

For reasons cited earlier, I have to believe that any reasonably fair system of implicit rationing, especially one based on changes in tax policies and on a federally mandated restructuring of health insurance coverage to incorporate significant coinsurance features, will have to be matched by equally significant changes on the supply side of health-care markets and on the price and revenue side of the health-care cost equation. Business as usual so far as pricing policies and pricing structures are concerned would simply doom any proposed changes to failure.

This may yet prove, however, to be the hardest nut of all to crack and may make tax reform seem like child's play. The plain truth is that we have worked very hard over the past 40 years or so in the medical and hospital care industries to accustom ourselves to the benefits as well as to the disadvantages of the heavy hand of government intervention. And we have learned well.

There is considerable comfort in knowing, for example, that planning agencies will very likely block any new-entry competitors into our business almost whenever we want them to and will effectively guarantee the continuing integrity of what we like, at least

in the hospital industry, to call service areas and turfs rather than market shares. And we are not, on balance, entirely displeased that rate-setting bodies, although they are very often humorless and a nuisance, actually ensure the continuance of usual, customary and reasonable fees-for-service and reimbursement based on full-costing, albeit prospective, budget reviews.

The supply side of the health-care house is a relatively untroubled world, all things considered, and there are very few physicians or hospital administrators who have any particular reason to perturb the serenity of the trade. Very few, in fact, even want to think of themselves, their firms or their institutions in terms of a production function. We in medicine are quite content to reserve that particular sobriquet for those of you in dentistry.

It is interesting in this context to recall for a moment Henry Ford's remarkable comments in 1923:

"Our policy is to reduce the price, extend the operations, and improve the article. You will notice that the reduction of price comes first. We have never considered any costs as fixed. Therefore we reduce the price to the point where we believe more sales will result. Then we go ahead and try to make the prices. We do not bother about the costs. The new price forces the costs down. The more usual way is to take the costs and then determine the price; and although that method may be scientific in the narrow sense, it is not scientific in the broad sense, because what earthly use is it to know the cost if it tells you that you cannot manufacture at a price at which the article can be sold? But more to the point is that fact that, although one may calculate what a cost is, and of course all of our costs are carefully calculated, no one knows what a cost ought to be. One of the ways of discovering . . . is to name a price so low as to force everybody in the place to the highest point of efficiency. The low price makes everybody dig for profits. We make more discoveries concerning manufacturing and selling under this forced method than by any method of leisurely investigation."

That just doesn't sound, I must sadly admit, like the pricing strategies of any hospital in which I have ever worked. Only the part about taking the costs and then determining the prices fits with my experience.

One has to wonder, accordingly, if we wouldn't be better off as an industry by adopting Mr. Ford's model and whether the public interest might be better served and an economically sensible method of achieving socially desired objectives might more

easily be achieved if some type of governmentally supervised price deregulation and price competition were implemented in the health services industry in lieu of what seem to be continually expanding government controls.

It would be positively fascinating to see what might happen if the product orientation which dentists have often been unjustly accused of promoting were consciously and deliberately re-introduced into the medical care and hospital industries; if hospitals were encouraged, in fact, required, to set their own prices for hotel, professional and support services rendered on the basis of an all-inclusive fee or charge per admission for the medical and/or surgical treatment of specific diseases or groups of diseases; if patients and third-party payors were provided with a meaningful financial incentive to shop around for what patients thought was the best available deal for obtaining hospital care on a timely basis; and if the intricate and complex doctor-patient-hospital-third party payor relationship were restructured so that there could be, as in ordinary business transactions, an offer to sell and an offer to buy at a mutually acceptable price. Were we also to establish, as we easily could, a governmental body which would determine, arbitrate and enforce the rules-of-the-health-care-game in much the same manner that the Securities and Exchange Commission does in securities markets, we might perhaps be able to do what no market has been able to do for itself and what no government has as yet been able to do for the nation. We might, just might, be able to put reasonable and acceptable and effective limits on both the quantity and the price of health-care services which are utilized at any given time.

Under these circumstances, the considerable governmental bureaucracies which now exist at federal, regional, state, and local levels could conceivably redirect their energies and talent toward ensuring that nearly equivalent physician, dentist and hospital alternatives exist in all geographic markets; that price and non-economic competition between and among various suppliers of health-care services is fair; that technical monopolies and other market imperfections are minimized; and that special populations, such as the poor, near-poor and aged, are provided with vouchers or related means of access which will prevent them from being excluded from deregulated markets for economic or any other reasons.

If, finally, we recognize, as others have not, that a competitive price system provides the most efficient and fairest mechanism as yet devised for allocating scarce resources and if we retain a decent amount of respect and responsibility for one another in coming

to grips with problems of inequality and will do so in ways which do not destroy the performance capability of our economy, I for one have no doubt at all that we can manage and that we will manage handsomely.

The author is:

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Former Professor of Business Administration
and Director,

Executive Graduate Programs in Management, Loyola College
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INFORMATION FOR CONTRIBUTORS

I. GENERAL INFORMATION

The Journal encourages the submission of manuscripts in the areas of dental research, service and education.

One original and two copies of manuscript with illustrations should be sent to the Editor-In-Chief, The Journal of the Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore, 666 W. Baltimore Street, Baltimore, Maryland 21201. The articles which are submitted for publication are expected to follow the format suggested below. It is assumed the paper is based on original data.

II. TEXT SECTIONS

Each article should be sequentially arranged as follows:

- A. Abstract
- B. Introduction
- C. Materials and Methods
- D. Results
- E. Discussion
- F. Acknowledgements
- G. References

III. MANUSCRIPTS

Manuscripts must be typewritten on one side only, double spaced with liberal margins of all text materials, references, and legends. Manuscripts ordinarily should not exceed 10 to 12 double-spaced typewritten pages (excluding references, figures, and tables). Include a title page with the title of the manuscript and complete author(s) identification, including name, degrees, title or academic rank, institutional affiliation and address.

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References cited bibliographically should be keyed to the text material, numbered in order of appearance, and placed at the end of the article.

- A. Journal citations.
Doe, J.J., Brown, D.M., and White, S.T.:
Fibrillogenesis in the Dental Sac, *The Journal*,
21:55-63, 1966.
 - B. Book or monograph citations:
Doe, J.J., and Brown, D.M.: *Inheritance and
Development* (Edited by White, S.T.), chap. 1,
p. 16, University Press, Baltimore, 1966.
 - C. References in press or personal communication.
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The Journal (in press), 1966.
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Original drawings should be prepared in black India ink. Typewritten or freehand lettering is *not* acceptable. All lettering must be done professionally. Do not send original art work or x-rays. All illustrative material should be submitted as 5" x 7" glossy photographs. For good black and white reproduction, contrast is essential. Illustrations will not be returned unless specifically requested. All illustrative material *excluding tables* should be indicated as figures. Each illustration should be keyed to the text and numbered consecutively. The back of each photograph should bear the following information: figure number, descriptive information, author(s) and reference to top of illustration. Descriptive information for figures should be concise but include all of the pertinent information, e.g., technical data such as stains or magnification. NOTE: Color photographs will be accepted only if the author agrees to pay the additional cost for their reproduction.

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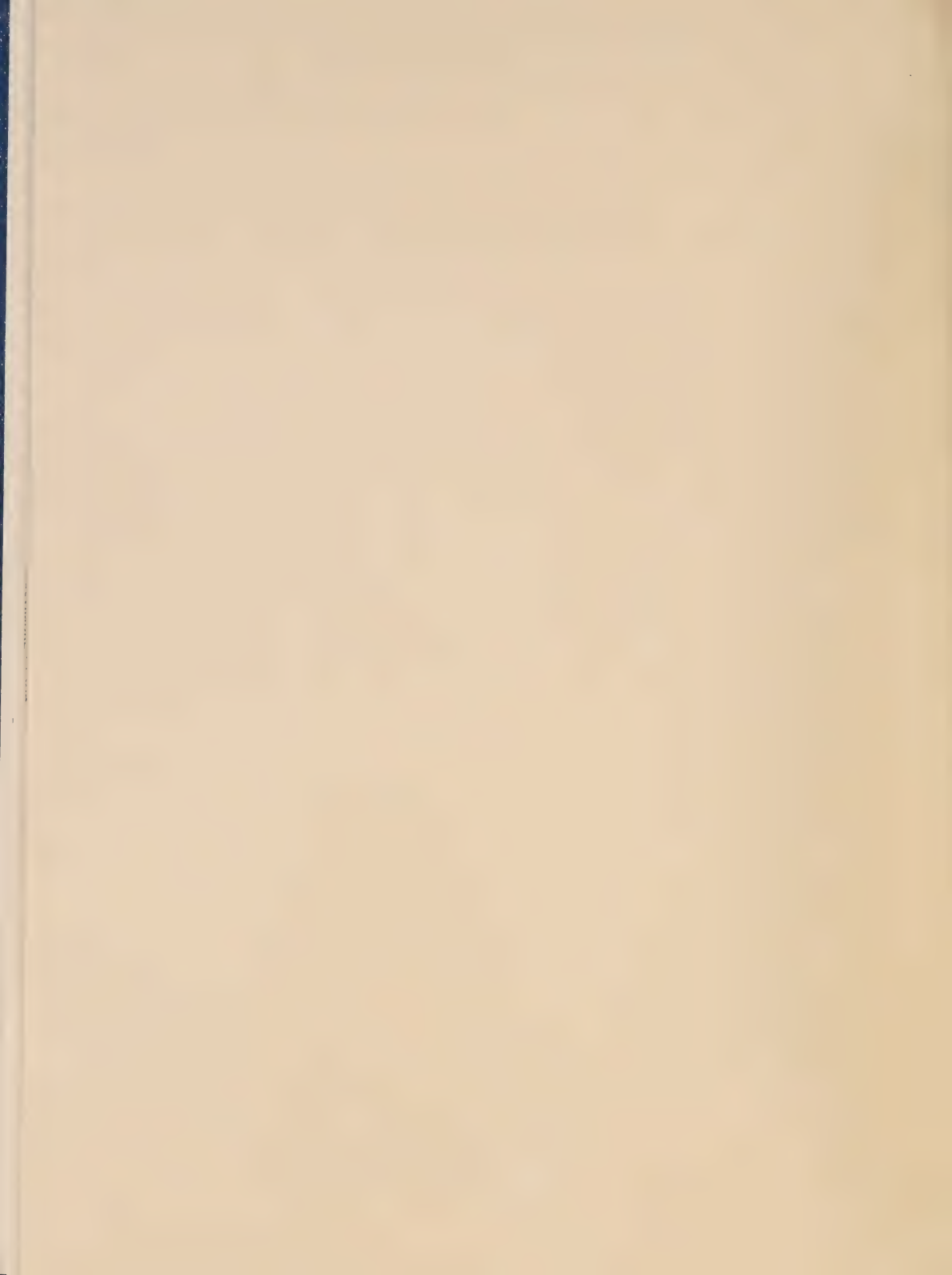


March, 1937

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All statements of opinion and of supposed facts are published on the authority of the writer under whose name they appear and are not to be regarded as the views of *The Journal of the Baltimore College of Dental Surgery* unless such statements have been adopted by the *Journal*. Articles are accepted with the understanding that they have not been published previously and that they are submitted solely to the *Journal*.

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Baltimore College of Dental Surgery
Dental School
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666 W. Baltimore Street, Baltimore, Maryland 21201

Dental College in the World

July 1985

Dear Friends:

It is with regret that I must inform our subscribers and contributors that this issue of the Journal of the Baltimore College of Dental Surgery, Volume 37, No. 1, will be the last.

This Journal has had a long and useful life. The decision of the faculty of the Baltimore College of Dental Surgery to publish a journal was a positive step towards furthering the profession of dentistry. Those involved in the initiation of this Journal should be proud of the manner in which it has served our profession. The profession is truly indebted to those who initiated the Journal and all those faculty members who served as contributors, editors, and members of the editorial staff.

In more recent years, there has been a proliferation of scientific journals dedicated to the science and art of dentistry and its various specialties and subspecialties. The development of these journals during the past two decades has filled an important need within the profession. At the same time, the Journal of the Baltimore College of Dental Surgery has attempted to maintain itself as a high quality publication and further scientific knowledge. While other journals increased, subscriptions and contributions to our Journal decreased.

During the past decade, the Journal and other publications of the Baltimore College of Dental Surgery have undergone two evaluations. Most recently I appointed a special ad hoc committee, made up of faculty, alumni and friends of the Dental School, to review whether or not this Journal should continue to be published. Their report was presented to the Faculty Council, and the Faculty Council voted unanimously that the Dental School should discontinue this publication after this issue, and that the funds which have supported this publication should be used to further the art and science of our profession just as our Journal was initially funded to do.

I hope that our subscribers will understand the need to apply these resources in a more appropriate direction in the future.

Best wishes.

Sincerely,

Errol L. Reese
Dean

Editorial—The End of the *Journal of The Baltimore College of Dental Surgery* (1937–1985)

The first issue of the *Journal of the Baltimore College of Dental Surgery* was published in March of 1937 under the direction of Brice M. Dorsey, editor and with the able assistance of Gardner P. H. Foley, associate editor. The Forward of the first issue read:

The publication of the *Journal* marks the achievement of a long-felt desire on the part of the students, the faculty, and the alumni of our School. Through it the School will be able to present to the undergraduates and graduates a record of their various activities. It will afford both students and alumni effective means for the publication of their writings. The *Journal* should find an important place among the School's contributions to its members and to the profession.

The publication of the *Journal* was originally supported by the Alumni Association of the Baltimore College of Dental Surgery, Dental School, University of Maryland; and the Grieves Library Foundation of the Maryland State Dental Association. The Grieves Foundation was established as a memorial to the distinguished alumnus, C. J. Grieves of the class of 1888, "in recognition of his outstanding contributions to the advancement of dental science." The funds in this foundation were designated to be used, "for the purchase of books, pamphlets, journals or other similar material or for the best interests of the Library and for the purpose of defraying in whole or in part the expense of publication of research or other bulletins."

After forty-eight years, a ten-person committee selected to review this publication's future recommended it to be discontinued following this issue.

According to Dr. James Craig, editor-in-chief of the *Journal* and chair of the committee, several factors influenced the committee's decision. First, the committee felt that many other vehicles existed for faculty members to publish their work. Second, it was felt faculty should be encouraged to send scientific articles to refereed journals in order to ensure proper recognition is given for promotion and tenure purposes, and third, the committee felt that the *Journal Of The Maryland State Dental Association* and the *BCDS FORUM* provided ample opportunities for faculty members to publish items. The high cost associated

with, as well as the human resources needed to publish the *Journal* also contributed to the committee's decision.

The committee's recommendations were presented to the Dental School's Faculty Council for discussion and consideration prior to discontinuing this publication. After reviewing the committee's recommendations, it was moved, seconded and carried that the *Journal of the Baltimore College of Dental Surgery* be discontinued. All subscribers will be notified of this decision and repayment will be issued.

The committee, which met on January 21, 1985, included Dr. Ernest Moreland, associate dean for academic and student affairs; Dr. John Hasler, associate dean for clinical and hospital affairs; Dr. Werner Seible, associate professor of anatomy, in place of Dr. Vincent Provenza, chairman of the Anatomy Department, who is on sabbatical (Dr. Provenza served as editor of the *Journal* from 1969–1978); Dr. Donald Shay, formerly assistant dean of Biological Sciences and editor-in-chief of the *Journal* from 1980–1981; Dr. John Bergquist, chairman of the Periodontics Department; Dr. Bernard Gordon, editor of the *Journal of the Maryland State Dental Association*; Ms. Ellen Yampolsky, editor of *BCDS FORUM*; Dr. Frank Romeo, editor of the *ALMA MATER*; and Ms. Betty Caldwell, director of campus development.

As the last issue, it seemed apropos to publish two articles discussing the future of dentistry. The first, written by Gordon M. GaNun, D.D.S., appeared in Volume 1, #1 of the *Journal of the Baltimore College of Dental Surgery*, March, 1937 and was entitled, "Dentistry—A Health Service." The second, written by Allan J. Formicola, D.D.S., Dean of Columbia University, School of Dental and Oral Surgery, was the keynote address presented to the Baltimore College of Dental Surgery faculty during the 1984 retreat in Ocean City, Maryland. It is anticipated that you will find the two discussions of the future of dentistry interesting.

James F. Craig
Editor-In-Chief

Dentistry—A Health Service*

Gordon M. GaNun, D.D.S.

Nineteen years ago, I graduated from the old Baltimore College of Dental Surgery and with my little kit of instruments went to New York to practice Dentistry. It hardly seems possible that one's profession and one's conception of that profession could have so changed between then and now. No one has a fonder memory nor a deeper appreciation of the part our School has played in stimulating the thought and effort which have brought dentistry to its present place in the world. I hope I am not revealing any secrets—and if I do it is with a feeling of great respect for my Alma Mater—but I must confess that my college training emphasized mechanics rather than health. The value of a Roentgenographic examination as an aid in diagnosis was not considered important nor essential. I remember that one of our professors summoned an electrical engineer to turn the switch, which sent a tremendous spark across a gap a foot long. The patient, entering with little more peace of mind than one about to be electrocuted, was exposed to the rays of the great Roentgen; while students and instructors looked on apprehensively, hoping for the best. The film when developed, I am sure, was appreciated only by the patient. Our finest minds were discussing the possibilities of permanent injury being done nerve tissue by injections of novocaine; and conduction anesthesia was practiced by only one man on our faculty, its results being received as an almost uncanny novelty. All abscessed teeth were opened, drained and treated, finally receiving a root filling which was pushed in the direction of the apex until the patient said "ouch." If a tooth looked too bad, it was covered with a gold crown to segregate it from the rest. Viewing in retrospect, one would believe that in those days the mouth and teeth had no connection with the circulation of the human body. Today we behold the new Baltimore College of Dental Surgery and the new dentistry. At first we are amazed and then truly inspired by progress, for today our patients demand Roentgenograms, demand conduction anesthesia and look askance at the gold crown. Dentistry today is a health service.

It is here most fitting to discuss dentistry in such a light, for our young colleagues who have just received their diplomas go out into the world well prepared to take care of the health of our people. They have had a broader training than those of us who graduated a few years ago; theirs is a broader field, one that will require courage, understanding and vision, for these men are entering a sphere of health service. We who have come home to visit our Alma Mater fully realize the importance of their task and ours; for we have only to visualize the oral cavity and the adjacent structures, to consider the beauty and function of the organs of mastication and the part they play in digestion, assimilation and nutrition, to realize the intricacies of the structure of the mouth and how intimately its normal balance is related to general health. The mouth is the portal of the human body. We are its guardians. Who is there to deny that this responsibility is a health service?

Let us not begin by criticising dentistry, emphasizing its shortsightedness, belittling dentists for over-indulgence in their mechanical art. Let us be proud, let us be self-respecting, that we may win the respect of others. Dentistry need not humbly apologize to the world. Its history is a record of achievement and of service. Horace Wells of Hartford, Connecticut, in 1844 first discovered nitrous oxide and successfully applied the use of gases whereby surgical operations could be performed without pain. Dr. William T. G. Morton is credited with making known to the world the discovery that surgical anesthesia could be produced through the medium of ether. The work of Dr. G. V. Black and Dr. Miller in behalf of humanity are known to us all.

Prevention has lagged behind the curative and restorative phases of our work, but is this not the way of human progress? The prevention of dental ills must be our constant aim and ultimate goal, but we must face our problems in a practical manner. The solution of these problems has progressed slowly and is dependent very often on the accomplishments of kindred sciences. Dentistry, while striving to prevent, has taken the next best course: cure and restoration. We must not flit off into the clouds and discard our technical procedures because we feel that the realm of prevention is more glorifying. We all love peace; but until peace is assured, let us not surrender our armamentarium.

The elimination of disease tissue in the mouth is essential to good health; and the extraction of teeth is often indicated. When a carious lesion has been removed, the anatomical restoration of the part is a definite health service. The replacement of one or more teeth requires a comprehensive knowledge of biology and structural anatomy; the ability to apply this knowledge in prosthesis is necessary if the health of the patient is to be served. Have we not all seen cases in which an esthetically effective prosthesis has so improved a patient's mental attitude that he has replaced a state of hopelessness with a spirit of happiness and a will to live? Is this not a health service of which the neurologist would be proud?

Our accomplishments are a matter of record but we must not be blind to the wisdom of our critics in the profession and outside it. Remember that a wise man despises not the opinion of the world but estimates it at its full value, for it is acknowledged that legitimate criticism is desirable in the unbiased interchange of thought.

Many preventive measures are at our disposal which we do not utilize. This is especially true in our treatment of children. Dentists do not take their little patients seriously enough. If we do not assume a

responsible attitude, how can we expect their parents to do so? Odontectomy in the first permanent molars and in other permanent teeth, where indicated, is one of the greatest advances in the prevention of disease in the last twenty years and for this Dr. Thaddeus Hyatt deserves our most gracious thanks. Do you follow this procedure in your practice? Many cases of adult malocclusion would never occur if the condition has been recognized in its incipency and preventive treatment prescribed. In no field of dentistry is prevention so little thought of by the general practitioner as in periodontia. Here just a simple adjustment would very often save the patient from an advanced periodontoclasia later in life. How often has the loss of one molar thrown the entire dentition out of balance. Let us not in our smug self-sufficiency fail to recognize and apply those preventive measures which recent advance in science and the contributions of bacteriology, pathology and Roentgenology have made possible.

Individuals outside our profession are justifiably confused concerning dentistry today because of the variance of opinion among us as to diagnosis, treatment and prognosis of specific conditions. Sufficient data have been accumulated as a result of research and clinical practice to make possible more definite and consistent diagnosis and treatment than is usual today. Too often this phase of our work reflects a fad, fancy or prejudice the operator has acquired during college training or in practice, rather than the consensus of scientific opinion. Our patients expect and are entitled to the enlightened truth.

The American people are health conscious. Is dentistry ready to take its place in this consciousness? Ninety-five million of our people receive no dental care. Deservedly or not, we are being severely criticized for this almost unbelievable condition, existing partly because these same millions do not associate oral health with general health. Perhaps we have thought too much in terms of bridges and plates in dealing with our patients and have failed to bring home to them that a neglected carious lesion is a possible potential cause of death. Caries is the most prevalent disease to which the human race is exposed today, the seriousness of which neither we nor the public is sufficiently aware. A cement filling which preserves the vitality of the pulp and the health of the tooth is a far more valuable service to the patient than an extensive precision appliance which leaves the patient with diseased teeth and foci of infection. Maintaining and protecting health and life is dentistry's function.

Dentistry's future is in our hands. About one hundred years ago, a small group, men of vision,

who thought of dentistry even in those days in terms of health service, petitioned the University of Maryland for the inclusion of a chair of Dentistry in the medical curriculum. The petition was denied, presumably because dentistry had no relation to medicine. Our independent dental schools followed; and only in very recent years has a small group of medical schools included medico-dental subjects in their prescribed course. The University of Oregon pioneered in this advancement. Happily for medicine, dentistry and the public, there now appears on all sides a better spirit of cooperation between physician and dentist. Surely they are interdependent and neither questions the value of the other to the patient; but because of its intricacies of practice, dentistry must remain a distinct profession. Through the efforts of one of our greatest champions and benefactors, Professor William J. Gies of Columbia University, in organizing the International Association of Dental Research and in establishing the *Journal of Dental Research* for the publication of its findings, dentistry has been recognized as an applied science and takes its place beside medicine and the other healing arts in the field of health service.

The thought which should be upper-most in our minds when examining a mouth is to think of it as an organ which functions biologically and mechanically just as do the heart, lungs, stomach and kidneys. If any of these organs is partially incapacitated, the other organs must assume its duties if a normal amount of energy is to be produced in the body and tissue resistance maintained. That wholly vital organ, the mouth, the entrance to two of the most important systems in the body, respiratory and digestive, is, I fear, seldom thought of as an organ in the true sense. If this organ is not in perfect condition mechanically so as to perform its duties, if it is not absolutely clean and free of infection, the realization of perfect health is beyond our grasp. If the vestibule of our body is not in order, it follows that our body is also disordered.

Dentists must think first of their patients' health, then of their teeth. How often when we have made a complete Roentgenographic and clinical examination of a mouth which reveals one or more foci of infection, does the patient on being apprised of this serious condition tell us that he is suffering no pain or discomfort and does not think he will subject to any procedure for the elimination of the foci. This is seldom the procedure when a cardiac or kidney lesion is detected. *Why?* Because the dentist is not sufficiently health conscious to have made his patient think of a diseased mouth as a latent cause of a diseased body. When our work is fully appreciated, we shall deliver sound healthy teeth; not inlays, bridges and plates

which are but means to that end. We shall diagnose and prescribe health. Dentists must believe their work to be a health service in order that they may convince their patients that it is a health service. Sixty-one percent of the cases admitted to the Mayo Clinic are the result of dental foci of infection past or present. Is this fact accepted by the laity of the country today? No! Because dentistry has not told a convincing story. To convince, believe!

Success is directly proportionate to our vision. Let us have the vision of the men who have gone before us and we shall deserve a place in the health centers of tomorrow.

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Dental Education in the Future

Allan J. Formicola, D.D.S.

Thank you for inviting me to be your keynote speaker. The subject of this address—*Dental Education in the Future*—has been on the minds of many. Interest in the topic has steadily grown during the 1980s. All recognize that the environment in which we live today is complex and that all segments of society are searching for new directions to meet the challenges of the future. Dental education is no exception. The American Dental Association in its 1983 Future of Dentistry report, the Kellogg Foundation reports on the dental curriculum and even the public press have recently and with increased frequency addressed themselves to changes in dental education. The concern is broader than dental education as both law and medicine—which just issued its own future report entitled "Physicians for the 21st Century"—are reexamining their educational programs.

As we begin to consider the current trends in dental education two questions need to be explored and understood. They are:

- (1) What factors influence and thereby cause a climate for change in dental education?
- (2) What are the current directions of change and what do we hope to accomplish by them?

It is especially important that these matters be explored here. As the oldest organized dental college in the world, the manner in which this faculty makes plans to respond to changing trends will be watched nationwide. Let's then explore these two questions.

In order to understand the factors which influence our curriculum today, the dental educational system must first be viewed historically and in broad context. Historically, three factors have influenced the dental curriculum. They are:

- (1) a desire to have scientific knowledge and thinking as the basis for the dental educational system.
- (2) technical competence or skill development in the student.
- (3) societal issues.

The former two influences—scientific knowledge and technical competence—were the most important influences on the dental curriculum for the first 60 years of this century, while during the past twenty plus years societal issues have also become influential factors. Thus, today, the dental faculty finds a complex and often perplexing set of problems to consider in analyzing the future curriculum.

HISTORICAL INFLUENCES ON DENTAL CURRICULUM

The development of the curriculum in dental education can also best be described as an evolutionary process in which these three factors predominated in different ways at different times. However, most evolution has revolution as its seed and dental education is no exception. The overall curriculum plan of today emerged as a result of a revolution to rid the country of proprietary

or "for profit" dental schools which flourished in the early 1900s. These schools, set up by the practitioners of the day, could better be described as "trade schools" or a system of apprenticeship rather than academic institutions. There were no prerequisites for entry into these dental schools, and the education was based mainly on the whim of the practitioner teacher. The public could not be assured that the dentist completing such training was practicing his profession on a rational basis and the quality of patient care provided by the graduate was generally poor. In the early years of this century, there was a growing awareness in the nation that change in dental education was necessary, and the major universities in the nation slowly became convinced that the practice of dentistry required a university level education. Finally, the Carnegie Foundation supported a five year study of dental education. A commission headed by William Gies, a Professor of Biochemistry at Columbia, published its report in 1926.¹

A quote from the Gies report provides us with a glimpse of the problems confronting dental education then:

"—Many [dental schools] established during the past thirty-five years were mercenary ventures which deserved the extinctions that awaited them. In the early days of dental education it was found, by the commercially alert, that the ownership and conduct of dental schools, could be developed into a very lucrative business . . . there were chartered in Illinois alone during the period from 1883 to 1902, . . . , twenty-eight dental schools. Some of the dental schools of this period were busy diploma mills, which, . . . freely sold the degree of doctor of dental surgery at home and abroad, to the disgrace of the profession and to the dishonor of dental education. One of these schools, selling its diploma for ten dollars, found a ready market in Germany."

The Gies report is credited with changing this deplorable situation through its recommendations. The report established (1) at least two years of college prerequisites for entrance into dental schools, (2) sound scientific thinking and the biological sciences on which dental schools should base their clinical education and (3) dental education and research as the major goals for the dental faculties to pursue. The development of a natural system to accredit schools helped implement the goals of the Gies report. As a result of the Gies report, the proprietary or for profit schools closed and were replaced by university based dental schools.

Since the publication of the Gies report, most of our attention in dental education has been directed toward achieving the scientific foundation for the professional dental education and balancing that goal against the question of skill development or technical

competence in the student, the second major influence on the dental curriculum. O'Rourke and Miner² in their 1941 report on Dental Education in the United States summarized this balancing act best when they wrote the following:

"A common aim of dental education has been that of providing opportunities for the development of 'skill' . . . The traditional, but fallacious, concept of skill as something almost entirely manual is common, . . . The great concern for manual ability and digital dexterity as the controlling factors in effective service implied a denial of existence or at least the significance, of dentistry's intellectual content . . . It is of course obvious that the dentist must engage in many manual activities . . . motor activities must be incidental to intellectual effort if the dangers of rule-of-thumb methods and empiricism are to be avoided."

So, early dental educators, not unlike us today, needed to balance the scientific goals of their programs with the technical demands of dental practice of the time. These two predominated as the most important factors influencing the development of the curriculum up until the 1940s.

INFLUENCE OF WORLD WAR II

The nation then began to expect its educational institutions to help during periods of national crisis. Thus we find the first such example of a response from dental education to World War II when schools drastically altered their programs to graduate more dentists for the war efforts. As the 1930s closed dental schools nationally produced the fewest graduates in decades from its schools. The military required all of its soldiers to have their dental problems taken care of prior to being shipped overseas. To handle this increased demand for services the dental schools accelerated their existing programs and graduated their students earlier. By converting to three year programs they were able to push more students through the pipeline quicker to provide services for the war effort.

The war did not have a lasting effect on dental education since all schools but one reconverted to four year programs, but this first foray into responding to a national crisis eventually would lead, over the next twenty years, to government expecting the nation's dental schools to help solve other problems facing society. However, it would take some time for such to happen and the period of time from the end of the second World War through the Eisenhower years can best be characterized as a return to better implementing the goals of the Gies report. A significant step forward in achieving academic dental schools was taken when some universities encouraged some dentists to gain substantial research training by offering Ph.D. programs to them. Coupled

with the development of the National Institutes of Dental Research, the quality and quantity of dental research grew. Slowly better management of oral disease became possible from scientific inquiry. High speed instrumentation revolutionized cavity preparation. The Kingston-Newburg fluoride studies demonstrated that dentistry had the means to prevent a good deal of the nation's caries problems. In practice dentists began to paint topical fluorides on their patients' teeth and the widespread use of local anesthetics made restorative care more humane. The dental curriculum continued to stress a strong basic science education as a cornerstone to the clinical years in schools. Because repair of teeth or replacement of teeth lost to caries was the most overwhelming problems facing practitioners, the clinical dental curriculum continued to stress restorative dentistry.

By the beginning of 1960, the dental curriculum and therefore, dental education had been mainly influenced by two factors:

- (1) a realization that scientific thinking should replace clinical empiricism as the basis for dental education. College prerequisites directed toward chemistry, physics, and math as well as basic sciences in dental schools became an expression of this influence.
- (2) the prevailing oral health needs of the nation—namely restoration of the oral cavity as a result of the disease caries.

Simple and neat! While dental education showed it would help during a national crisis, social issues and research advances had not changed dramatically enough to cause dramatic influences on the curriculum.

SOCIETAL INFLUENCES

The 1960s changed everything and added a third major influence on dental education—a societal factor. For many in society the 1960s were the best times while others consider them the worst of time. The decade of the 1960s can best be characterized as a complex time of rapid societal changes and a phenomenal growth in the base of scientific and technical knowledge. Fueled by national leaders who believed in a guns and butter philosophy, the nation went through a major period of change. The results of those changes are influencing us today. What stands out most in our minds are the societal changes. The Great Society Program of the Johnson Administration, the unpopular and controversial Vietnam War, Nader's consumer movement, and the racial riots and unrest in the wake of the assassination of Dr. Martin Luther King have had lasting effects on this society. Federal and state laws changed dramatically as a re-

sult of these events and all walks of life—including dental education have been influenced.

Laws providing the Medicaid and Medicare were designed to open up access to health care for the nation's poor and the elderly. The 1970 Health Professions Manpower Law stimulated the professional schools to expand enrollment to provide care for the many new patients it envisioned would obtain care under Medicaid and Medicare. The Civil Rights Act of 1964 created a more pluralistic society in which women and minorities found entry into education and jobs through affirmative action. The college student rebellion introduced the word relevant to an education. The consumer movement produced a public demanding to be informed and wary of the quality of products and services. Hospitals wrote "Patient Bills of Rights," request for second opinions became common as private third party insurance grew and before we knew it our patients expected us to better inform them of what we were doing and why. No longer could physicians and dentists practice on a wary public with the old philosophy of don't question the doctor—he knows best. That philosophy was out the window.

Dental education became concerned. It encouraged women and minorities into their classes. Some courses were developed to help the graduates cope with this complex society filled with citizens more complicated to understand than previous generations. In an attempt to help the students understand these patients' overall needs better, coursework in the behavioral sciences was included in the dental curriculum and the Comprehensive Care Philosophy was adopted as the basis for the schools' clinic programs. In an attempt to inform students of the growing complexity in the financing of dental care, coursework in practice management started to discuss issues such as third party payment reimbursement systems.

As all these complex societal changes were happening major advances were occurring in the scientific knowledge base of the biological sciences. So fast were scientific breakthroughs happening that no one could keep abreast of the changes.

Accumulated knowledge led to significant advances in treatment of disease. For example, manipulation of the immune system has permitted organ transplantation. Cancer is not as mysterious a disease as it once seemed and new levels of understanding are aiding neurologic diagnosis. In our field the changes in disease patterns due to a decrease rate of caries in children already means less restorative care for one segment of society while demographic shifts and the prolonged retention of teeth require more care for the elderly. A keener sense of understanding

periodontal disease means it is more possible to take care of the population's periodontal needs with more assurance. Modern genetic techniques involving gene transfer have already begun to identify the genes involved in tooth formation. It can be expected further work will enable us to manipulate these as a means of dealing with genetic disease effecting the teeth.

Even the manner in which a new practitioner begins practice has become more complex. Costs have risen and practice locations more difficult to find. There are more opportunities for graduates to work in group practices and being employed rather than "your own boss" may be a way our graduates must consider for their practice careers. Students must, therefore, be prepared to enter this difficult practice world.

The dental profession began to recognize these changing times and in 1973, an ADA report entitled *Prevention and Control of Dental Diseases Through Improved Access to Comprehensive Care*³—also known as the Access Report—recognized the need for change. The Dental Education Section of The Future of Dentistry Report⁴ just recently completed by the ADA further recognizes that dental education is in the midst of great change. The Access Report urged dentistry to make care more readily available for the approximately 100 million or more Americans who presently have limited access to care. Thirty-two of the thirty-three recommendations presented in that ADA Report will require schools to provide dentistry with a new generation of graduates more deeply knowledgeable in subject matter now considered collateral to our current roster of clinical educational goals. The Future of Dentistry report acknowledges that schools face curriculum revision precipitated by a knowledge explosion, changes in disease patterns and a shift in demography.

FUTURE CURRICULAR CHANGES

These events and others have already had a limited impact on the goals of the dental curriculum. It is becoming more obvious to every person associated with a dental school that educational goals have experienced and are experiencing a slow but steady period of change. In short, the complexity of today's society and scientific advances mean there is no longer a question whether it is necessary for schools to change their educational goals. Like it or not the schools must change. The question now is, how does dentistry change its educational goals and at what pace is it necessary to make the changes? This turns

us to the final major question we must ask—What are the current directions of change and what do we hope to accomplish by them?

Various agencies and organizations have studied the question of how to change. Today, the most often heard suggestions can be boiled down to the following four:

- 1) considering altering the prerequisites for dental school
- 2) add a fifth year to dental school
- 3) add a required residency or an advanced general dentistry year
- 4) dental school curriculum revision

It is my contention that while the first three ways are attractive, all paths for creating lasting and good change to dental education led to the fourth—dental school curriculum revision—as a necessary step in the change process. As we come to conclusion on how to best cope with the dental school educational environment we can better answer the question of the changes necessary in pre-profession education, or whether an expanded length of time is necessary to prepare graduates for tomorrow's practice. Medical education appears to be placing major attention on the college preparation for medical schools as a method to cope with change. The October 3, 1984 issue of the *Chronicle of Higher Education* reports that Brown University is overhauling its medical program by admitting students directly from High School into an eight year program. The article states the University hopes the results will be a richer intellectual background for holders of the M.D. and ultimately better physicians. The goals of the program are to produce committed doctors, scholars and leaders who are able to deal with diversity and change in the health care system during their professional career. On the other hand, a good deal of the thrust in the annual report of the President of Harvard University⁵ directed and placed the burden of change on the medical school faculty and urges them to change their methods of instruction.

In dental education, calls for a fifth year of education or a required residency seems to be gaining as a means of coping with the change phenomenon. However, schools cannot become complacent in considering curriculum changes and basic reform in the educational environment because they assume that a fifth year of education or a required residency program will serve as a panacea for solving the problems. An additional year of education for all of our graduates is a long way off, yet all of our graduates must cope with this more complicated world.

An analysis of the numbers of available G.P. residency positions shows the impossibility of waiting for that to solve all of the problems. The number of general practice residency positions increased significantly in the eight year period ending in 1980. The growth in these positions was stimulated by grants from federal government and the Robert Wood Johnson Foundation. However, there is a significant number of graduates who do not pursue G.P. residencies or graduate specialty education. While the demand by students for G.P. resident positions far outstrips the number of positions available, it is unlikely that the number of G.P. resident positions will grow to permit each D.D.S. graduate to pursue such an experience during the 1980s. In the meantime, all of the graduates can benefit from exploring curriculum changes in the D.D.S. program.

Regarding the fifth year in dental school, the 1980 Kellogg report⁶ came to the following conclusion:

"Dental schools and their faculties must have exhausted every option to realize curricular deficiencies before recommending that the period of education be extended for all students."

The four year curriculum still is adequate, however:

"A very formidable task lies ahead in further revising and improving the predoctoral curriculum on a continuing and periodic basis."

The report further pointed out the following key points for schools to consider. Schools must

- present essential information
- make sufficient time available for students to integrate and refine knowledge while gaining clinical competence
- decrease the time devoted to exercises that do not contribute substantially to the development of a competent general dentist
- continue to make improvements through constant evaluation of predoctoral curricula

But it is generally acknowledged that the dental curriculum is already overcrowded and so schools cannot approach curricular revision or improvements by just continuing to add new material. Dental schools face hard choices and curriculum committees cannot approach the future with an add on mentality or without thoughtful consideration of the major factors influencing the field.

To accomplish curriculum revision in dental school, therefore, we must be willing to (1) first take a long hard look at the current educational philosophy in our schools and alter it if it is in conflict with today's needs, and (2) be willing to redirect specific course emphasis and educational methodology to meet a redirected philosophy.

Regarding the philosophy of professional educa-

tion, Morris Freedman, a professor here at the University of Maryland recently wrote: "Society's responsibility remains to see that all professionals who serve it are qualified in the fullest and most responsible way—technically competent, sensitive to the humane element of their professional commitment, balanced and informed in making those subtle, non-technical, philosophical determinations inevitable in any complex activity today."

The Kellogg Foundation's "Report of the Special Higher Education Committee to Critique the 1976 Dental Curriculum Study"⁷ narrows down that philosophical statement for dentistry in two of its recommendations regarding the impact of the needs of society on the preparation of dentists. They recommend that:

"The primary focus in dental education should be to prepare students to provide comprehensive patient care to all population groups including the handicapped and the medically compromised patient."

"The background knowledge, technical skills and clinical experience of the predoctoral student should be expanded in scope so that the graduate will be prepared to provide a broader range of services as a general practitioner."

The report further concludes that:

"to address these issues leadership must come from the schools of dentistry with support of the university administrative officers; willingness and ability of dental faculties with university encouragement to make change and adjustments in anticipation of long-term needs."

Certainly, if dentistry is to broaden the scope of its education to truly encompass the needs of society *faculties must take a long, hard look at what is currently influencing curriculum and be willing to make the changes necessary to catch up with science, technology and society.* This is not difficult, it is almost heroic to expect it to happen from within, but I believe that this can be done. *We have the capacity within the dental schools to do this without the prodding of outside pressures.*

In fact dental education made a fine start in examining these issues in the early 1970s when dental schools across the nation adopted the Comprehensive Care concept as the basis for their clinical educational goals. While the term has come to mean something different in each school, underlying each school's way of interpreting comprehensive care was the common understanding that a change of attitude must occur toward the orientation of clinical educational goals. That is, the education of students must be balanced to include learning how to recognize and manage, with sensitivity, the patients overall needs while learning the individual dental disciplines as well. Comprehensive care meant dentistry was to be concerned with more than just taking responsibility

for caring for the patients oral needs. It can be the basis on which schools truly integrate coursework and strive to develop the professional judgement in our graduates that today's society requires.

But to where do we turn in dental education for guidance in our attempt to realign our educational goals to be more in tune with societal needs and contemporary scientific knowledge? There is already a sufficient amount of background information to consider and the amount of information is growing each day. Some schools are beginning to use this already available information to do a total curricular assessment. If societal needs are considered along with what science now permits us to do, schools will find new directions and their educational goals would most likely slowly shift to emphasize those goals which would graduate a dentist who is prepared with the means to provide a more sensitive and broader mode of treatment.

It is my contention that dental education has the means at its disposal now to begin effectively that reexamination and that the Comprehensive Care Philosophy which we all so readily accept can help us in that reexamination. We do not have to wait until someone or something outside of the schools saves us.

In summary, I would like to close by relating to you an article I read in the New York Times which reported on a talk Henry Kissinger delivered to 900 members of the Association for a Better New York. "Kissinger Gives Optimistic View on World Issues," the headline proclaimed and I could hardly believe Kissinger was referring to the same world in which I live, given the continuing crisis in Lebanon, the mess in Central America, and our own arms buildup. But then as I read on Kissinger was quoted as saying, "the great turmoil we are presently experiencing also presents us with opportunities for a new world order." Now while I don't consider myself as the Henry Kissinger of Dentistry, I do see parallels between Kissinger's remarks on the opportunity for a new world order and dental education. The current conflicts between science, society and education are healthy ones which provide us with a good opportunity to realign dental education to better achieve our goals.

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Each article should be sequentially arranged as follows:

- A. Abstract
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Manuscripts must be typewritten on one side only, double spaced with liberal margins of all text materials, references, and legends. Manuscripts ordinarily should not exceed 10 to 12 double-spaced typewritten pages (excluding references, figures, and tables). Include a title page with the title of the manuscript and complete author(s) identification, including name, degrees, title or academic rank, institutional affiliation and address.

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References cited bibliographically should be keyed to the text material, numbered in order of appearance, and placed at the end of the article.

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Doe, J.J., Brown, D.M., and White, S.T.:
Fibrillogenesis in the Dental Sac, *The Journal*,
21:55-63, 1966.
- B. Book or monograph citations:
Doe, J.J., and Brown, D.M.: *Inheritance and
Development* (Edited by White, S.T.), chap. 1,
p. 16, University Press, Baltimore, 1966.
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Original drawings should be prepared in black India ink. Typewritten or freehand lettering is *not* acceptable. All lettering must be done professionally. Do not send original art work or x-rays. All illustrative material should be submitted as 5" x 7" glossy photographs. For good black and white reproduction, contrast is essential. Illustrations will not be returned unless specifically requested. All illustrative material *excluding tables* should be indicated as figures. Each illustration should be keyed to the text and numbered consecutively. The back of each photograph should bear the following information: figure number, descriptive information, author(s) and reference to top of illustration. Descriptive information for figures should be concise but include all of the pertinent information, e.g., technical data such as stains or magnification. NOTE: Color photographs will be accepted only if the author agrees to pay the additional cost for their reproduction.

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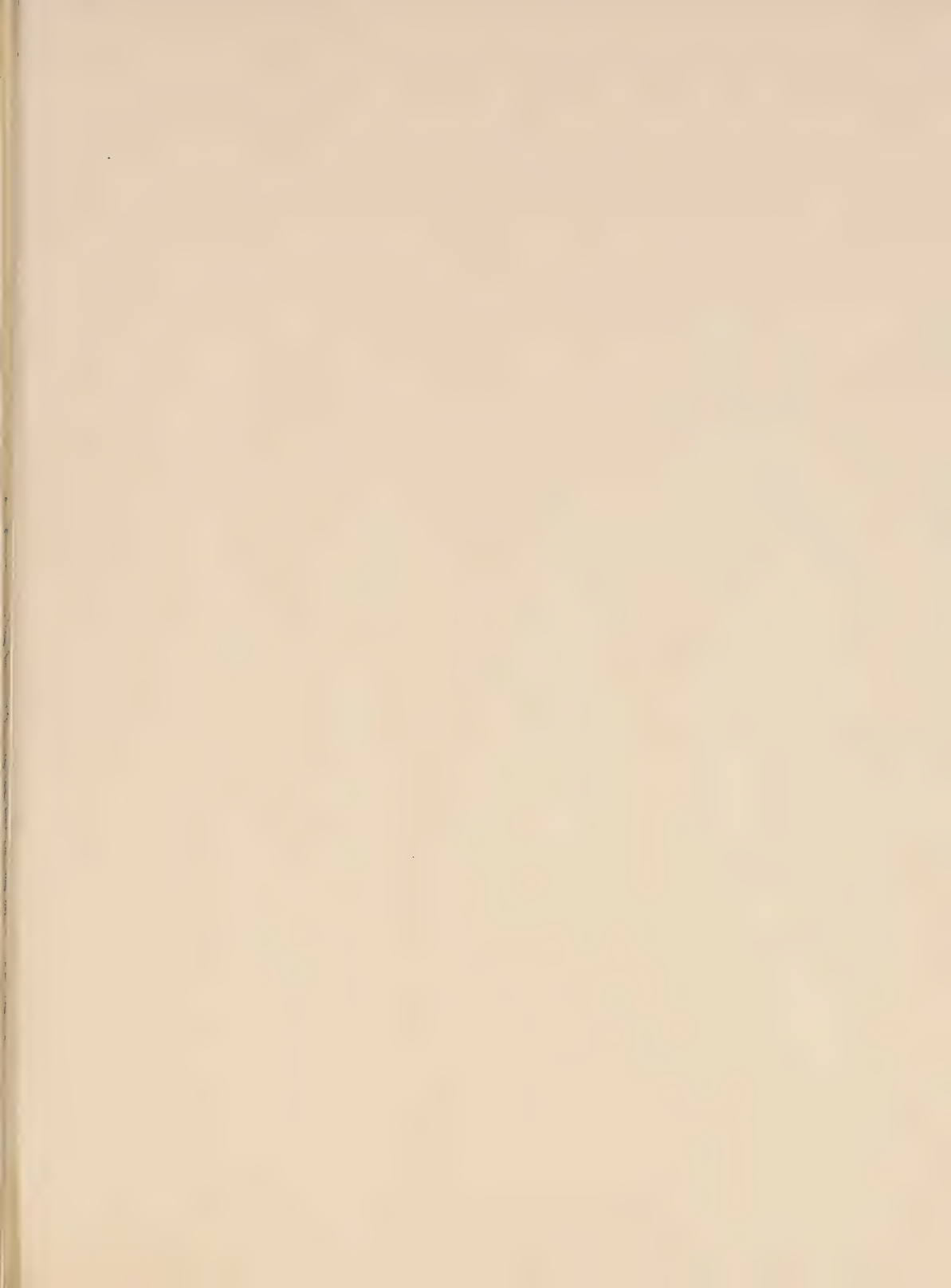
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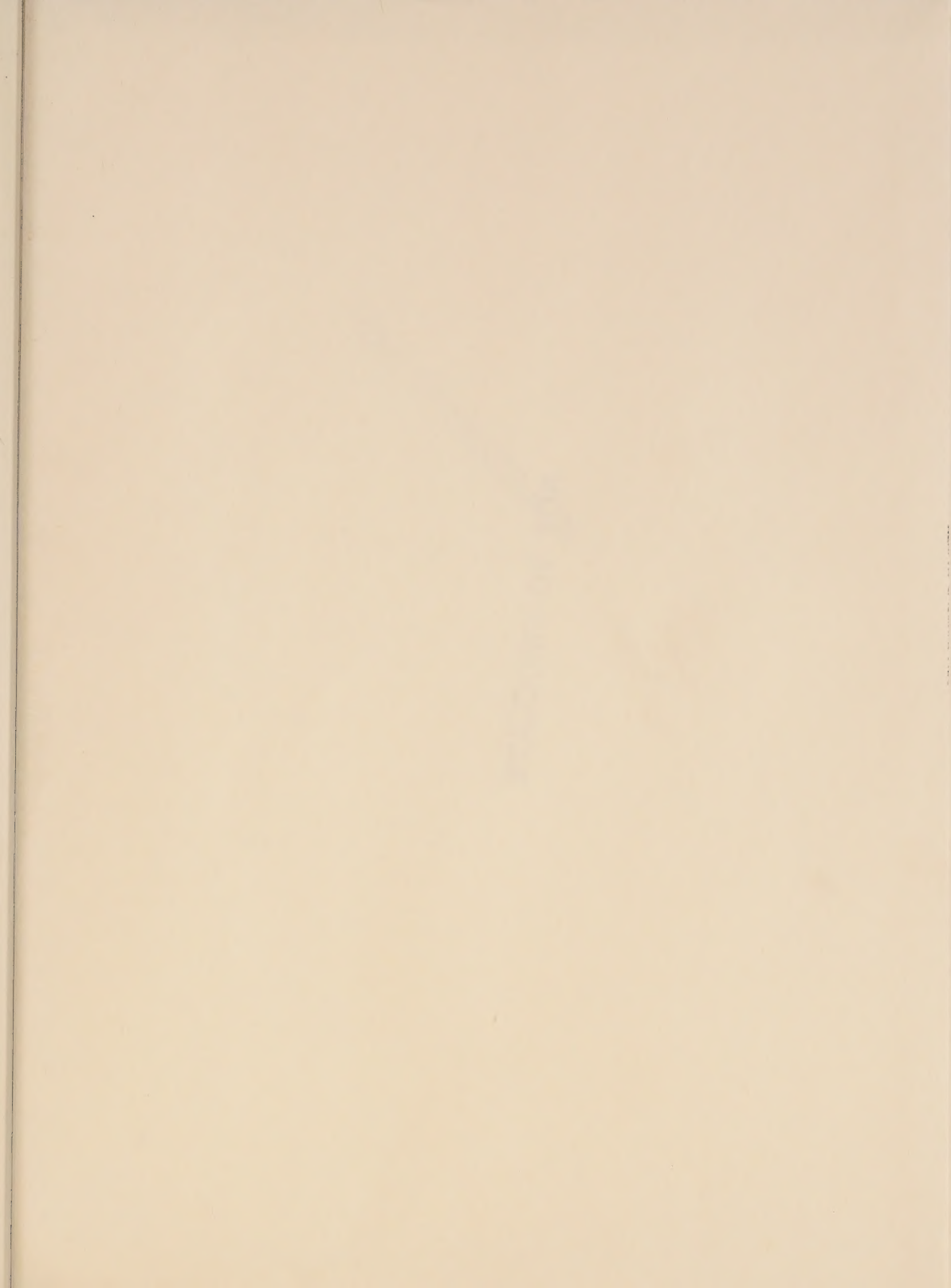
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